Are "Ambulance Chasers" That Bad? Litigation, Lawyers' Advice, and Social Welfare*

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Abstract

This article models litigation in signaling games with an imperfectly informed victim and a perfectly informed defendant. I compare a two-agent game and a three-agent extension where the victim can hire a lawyer who is perfectly informed but who pursues a selfish objective in his advice. In particular, a lawyer affects a victim's information environment in a way that is similar to Bayesian persuasion (Kamenica & Gentzkow, 2011). Overall, this analysis captures some stylized empirical patterns of the legal system, and identifies both the positive and negative welfare effects of lawyers' advice on the number of cases filed and litigated, victim's trial winning rates, and defendants' safety costs.

Keywords: Signaling game, persuasion, litigation, welfare, safety costs, altruism.

JEL Codes: D02, D83, K13, K40.

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In many areas of the legal world, lawyers are associated with the practice of aggressive solicitation of clients. The extreme of such a practice is found in personal injury cases, and the term "ambulance chasing" describes its extent (Anderson, 1957). In general, overly aggressive client solicitation is frowned upon, and the solicitation of clients by lawyers is subject to regulations under lawyers' professional ethical standards.[1] However, it is important to ask whehter lawyers' aggressive solicitation of clients to encourage litigation really that bad. Considering the lack of access to legal resources and the information problem faced with many claim-holders, the answer seems to be more complicated (Schwab, 2010).

Admittedly, it is clear that too much litigation takes place in the U.S. today. For instance, in 2016, there were 83 million incoming civil cases in state courts, and, surprisingly, this number is found to be on the lower side when looking at recent history.[2] Ligation also consumes many resources. One study [3] shows that in 2016, the U.S. tort system alone cost \$429 billion, the equivalent of 2.3% of the United States' GDP that year, although tort cases account for only about 7% of the total civil cases in state and federal courts.

Still, claimants' litigious tendencies differ by category. There are two main groups of potential claimants: corporate and individual. Where corporate claimants tend to be quite litigious, individual claimants typically only litigate a small portion of their legal problems. For example, only 1% of job discrimination cases, 10% of tort problems, and 36% of real property problems lead individuals to seek lawyers, and only around 14 % of people injured by potential medical malpractice end up filing suits (Cramton, 1993; Hylton, 2007).[4]

[1]See ABA Rule 7.3 ("Solicitation of Clients"), https://www.americanbar.org/groups/professional_responsibility/publications/model_rules_of_professional_conduct/rule_7_3_direct_contact_with_prospective_clients/comment_on_rule_7_3/, last accessed September 11, 2019

[2]For more caseload statistics, see the Court Statistics Project, http://www.courtstatistics.org/, last accessed Feb 28,2020.

[3]U.S. Chamber of Commerce Institute for Legal Reform, "Costs and Compensation of the U.S. Tort System", Oct. 2018. https://www.instituteforlegalreform.com/research/2018-costs-and-compensation-of-the-us-tort-system, last accessed Feb 28, 2020.

[4]The court also acknowledges individual claimants' under-litigation problem in tort cases and uses

Individual claim-holders' under-litigation often stems from a lack of information. Claim-holders may fail to recognize that they are harmed, fail to establish the legal character of their problems, or fail to understand the relevant legal resources available to them (Cramton, 1993). In such situations, lawyers can supply the needed information and thus reduce under-litigation(Cramton, 1993; Calvani, Langenfeld, & Shuford, 1988; Greiner & Matthews, 2015).[5]

At the same time, lawyers' fees constitute a large portion of the total sums involved in litigation. Out of the total cost of $429 billion in the U.S. tort system in 2016, 57% went to the victims while 32% went to the lawyers[6]; That year, lawyers made $137 billion in tort cases alone – about 0.74% of the U.S.'s GDP (Doroshow & Gottlieb, 2016).

The ambiguity of lawyers' effects on individual claimants and thus on the potential defendants is the main motivation for this study. The two main objectives of this article are the following:

1. To model lawyers' effects on litigation in suitable signaling games.
2. To evaluate lawyers' effects on social welfare.

To realize these objectives, this article explicitly considers how a victim's lawyer affects an uninformed individual victim's decisions in a three-agent signaling game. Such analysis takes a different perspective from mainstream game theory models in law and economics regarding litigation choices, which focus on games between two opposing parties–the plaintiff and the defendant (Bebchuk, 1984; Reinganum & Wilde, 1986; Hubbard, 2017).

In the current study, a victim ("she") is injured from an interaction with a defendant

punitive damages and class action suits to alleviate this issue. Punitive damages augment the amount of damages paid by a defendant after considering the probability of escaping liability. In class action suits, one member can sue on behalf of the entire class to make up for the fact that many injured individuals are not suing. Punitive damages and class action suits are unusual under tort laws because the function of tort laws is compensation and restitution, rather than punishment and deterrence. However, the consideration to alleviate under-litigation is more important than the consideration to limit the scope of the function of the tort law (Lens, 2014; Polinsky & Shavell, 1998; Galligan Jr, 2005)

[5]Lawyers are helpful to their clients because they can obtain better information (rather than because they can supply superior oral arguments at trial) (Duvall, 2007). Most cases settle and never go to trial. If a trial does occur, a case represented by legal counsel has a higher winning probability and typically better outcome terms compared to a case without legal representation(Greiner, Pattanayak, & Hennessy, 2012). However, a judge usually forms opinions on the case's merits before a trial begins based on the information supplied by the parties, rather than based on oral arguments at trial (Duvall, 2007).

[6]Supra footnote 2.

("he"). There are two possible states: the defendant is either liable or non-liable for the injury to the victim. The defendant is perfectly informed of the states. However, the victim might or might not recognize that she is injured, and also might or might not be able to tell whether the defendant is liable. This situation is modeled as a victim who receives a noisy signal on the realization of the state after being injured.

In a two-agent model, if the victim gets a signal indicating that the defendant is liable, she files a claim against him, and litigation begins; otherwise, there is no litigation. If litigation occurs, there is first a settlement stage; however, if there is no settlement, then a trial occurs. The settlement stage is summarized as a signaling game, where the perfectly informed defendant offers either a positive settlement amount or offers zero to the imperfectly informed victim. A positive amount signals the defendant is liable; where as a settlement offer of zero signals that the defendant is not liable. The victim can either reject or accept the defendant's offer. If she accepts his offer, a settlement is reached; if she rejects it, the settlement fails, and a trial begins. This process represents the general chronology of a typical lawsuit.[7].

The setup of such a game is discussed in detail in section 2, where the timeline and game tree are given in figures 1 and 2. In a two-agent game where an imperfectly informed victim is not represented by a lawyer, in some settings, the victim might either (1) never recognize the harm done to them, and thus never file a claim; or (2) be stuck in a pooling equilibrium where they are not compensated. The two-agent baseline model in section 2 discusses such situations.

Section 3 adds a third player: a perfectly informed, profit-driven lawyer ("he"), who can affect the victim's information environment and payoffs. In particular, section 3 discusses a three-agent model where a victim is represented by a lawyer who is perfectly informed of the realization of the state (liable or non-liable) and of the victim's signal, and who collects fees for his services. This lawyer sends a signal to the victim. The lawyer's optimal signal structure is described in proposition 2. A lawyer's degree of information

[7]See, e,g. United State Courts, ("About Federal Courts", "Civil Cases"). `https://www.uscourts.gov/about-federal-courts/types-cases/civil-cases`, last accessed Feb 28, 2020

disclosure is determined by the signaling equilibrium in the settlement game between the victim and the defendant.

In aggregate, in equilibrium, lawyers may (1) inform victims that defendants are liable when the victims receive a wrong signal; (2) eliminate the pooling equilibrium where victims are never compensated; and (3) help the victims select liable cases to go to litigation, and thus, increase the victims' numbers of positive settlements and the overall trial success rate. Under appropriate settings, most victims can be compensated either through a settlement or via a trial. However, lawyers' fees decrease the settlement amounts and trial payoffs. Furthermore, lawyers induce more case filings for non-liable cases. A numerical example of this situation is given at the end of section 3 to illustrate such effects.

When a defendant's endogenous level of costly precaution determines his prior probability of being liable, the presence of a profit-driven lawyer may increase his precaution level and thus decrease his prior probability of being liable by affecting the signaling equilibrium. In particular, when a defendant's prior probability of being liable is a function of the costs he spends on preventing injuring others, the presence of a victim's lawyer can induce a defendant to spend more on safety costs to reduce the prior probability of being liable under a set of realistic parameters by increasing the amount of litigation. Detailed analysis is in Section 4.

This article also discusses several variations of the three-agent model. First, when lawyers are imperfectly informed, they can still increase the number of case filings and the amount of litigation, even though their solicitation efforts will be less effective. Second, if lawyers not only have financial interests in the cases but also internalize the utility of the victims to some degree above a threshold, they will report their true information to the victims. Here, the game becomes a complete information game. Finally, if trials do not reveal the true state, and the informed defendants can manipulate the judges' decision at trial, victims will lose many cases in which defendants are liable. However, if a victim is represented by a perfectly informed lawyer who can also persuade the judge, the trial becomes truth-revealing. These situations are discussed in detail in section 5.

1 Related Literature

The Bayesian persuasion framework originally developed in Kamenica and Gentzkow (2011) considers the setting of one sender and one receiver, where the receiver's action determines the payoffs for both parties. The sender can strategically conduct experiments to determine the states, and commit to truthfully reveal the results to the receiver. The receiver uses the signal from the sender to updates her posterior belief on the states according to Bayes' rule. By the choice of experiments, when the state space is small, the sender in effect can choose any posterior belief for the receiver, as longs the expectation of the posterior beliefs induced by a signal is same as the prior belief. The sender benefits as long as the receiver's action is discontinuous in beliefs.

Since Kamenica and Gentzkow (2011), there has been lots applications of Bayesian persuasion setting and its variants. The applications include optimal experimentation by a politician for different electoral rules (Alonso & Câmara, 2016), optimal grading in schools (Boleslavsky & Cotton, 2015), optimal design of online ads (Rayo & Segal, 2010), and optimal competitive information disclosure in costly search markets (Board & Lu, 2018), to name just a few. This article also considers an application of a variant of Bayesian persuasion. The setting is related to the one-sender-one-receiver situation of the depositor-regulator case with private signals in Bergemann and Morris (2016). However, I combine persuasion with a signaling model, which makes the analysis more comprehensive.

Specifically, a victim (receiver) receives a private noisy signal indicating the states, and the lawyer (sender) knows the true state and the victim's prior belief and private signal. In the terminology of Bergemann and Morris (2016), the lawyer is *omniscient*. Bergemann and Morris (2016) also defines *Obedience* as the condition that the receiver always follows the sender's advice.[8] To achieve this, the receiver's expected utility of following sender's advice needs to be higher than not following. This constraints the receiver's decision rule and the sender's signals. In the model presented in this article, in equilibrium, the victim's decision rule is obedient. When the lawyer tells the victim that the defendant is liable, the victim files a suit.[9] A lawyer makes a victim's decision rule obedient by choosing a signal to cause the victim's belief that the defendant is liable to be just above the threshold for her to file a case; where such threshold is determined in her signaling game with a defendant. A lawyer profits from persuasion by controlling the victim's belief when entering the signaling equilibrium and therefore inducing separating equilibrium where victims file suits and go to trial often.

The current article also contributes to the discussion in the legal literature on socially optimal levels of litigation and settlement (e.g. Shavell (1999)). Additionally, this article contributes to the discussion on the regulation of injurers' precaution levels. Some of the legal literature focus on regulation of tort injurers' activities and precaution levels via different liability standards (Gilles, 1992; Rosenberg, 2007; Hylton, 2002; Polinsky & Shavell, 2000). The present article adds to this discussion from a different angle, namely, how lawyers can help enforce any predetermined liability standards by helping victims recognize liable defendants.

2 Baseline Model: Two-Agent Settlement Game

The models of this article consider a victim's litigation decisions in a tort case after she is injured.[10] We first establish a two-agent model of a settlement game, where the players are a victim who is injured during her interaction with a defendant, and the defendant.

We first consider a complete information situation to determine the equilibrium settle-

[8] See also Definition 1 in Bergemann & Morris, 2019

[9] In the language of Bergemann and Morris (2019), the situation that the victim always follows lawyer's signals, is called a "truthful mechanism"

[10] In a tort case, the victim seeks monetary compensation (damages) from the injurer. Personal injury cases that arise from motor vehicle accidents, slip-and-fall accidents, medical malpractice, and injuries caused by defective products all belong to this category.

ment amounts from the defendant in the settlement game. Suppose the fair compensation to the victim, i.e., the adjudication amount from trial, is d. Suppose the court cost for the defendant is c_d, and for the victim is c_v. Therefore, a victim's payoff from trial is $d - c_d$, while her settlement payoff is σ. To avoid trial, a liable defendant will have to offer a settlement amount of $\sigma \geq d - c_v$. The equilibrium settlement amount would be $\sigma^* = d - c_v$ as the defendant maximizes his payoff, $-\sigma$. When the defendant is not liable, the fair compensation to the victims is zero, and the victim's payoff from litigation is $-c_v$. Thus, the victim will not go to trial even when offered zero settlement, and therefore the lowest non-negative payoff that V would accept would be $\sigma = 0$.

In the settlement game considered here, the victim is uncertain whether the defendant is liable to her or not, while the defendant is perfectly informed. In the game, the defendant offers either zero or σ^* to the victim. The former signals non-liable, and the latter signals liable. Therefore, this game is a typical signaling game.

2.1 Primitives

The defendant (D) is either liable (l) or non-liable (nl) to the victim (V). Thus, the state space includes two states: $\Omega = \{$ liable (ω_l), non-liable $(\omega_{nl})\}$ The realization of the state is exogenous.

V is imperfectly informed of the realization of the state. Her prior belief that D is liable is $p_0 = p(\omega_l)$, where $p(\omega_l)$ is the percentage of liable cases in the pool of all cases of the same type.[11] After the injury, V receives a noisy signal, z, whereby $z = 1$ indicates ω_l, and $z = 0$ indicates ω_{nl}. However, a false-negative occurs with probability β_0, and a false-positive occurs with probability β_1. Thus, each state generates z as follows:

[11] Such prior probabilities can be obtained in survey data or from insurance contracts.

$$
\begin{aligned}
&P(z=1|\omega_l) = 1-\beta_0,\\
&P(z=0|\omega_l) = \beta_0 \text{ (a false-negative, or type II error)},\\
&P(z=1|\omega_{nl}) = \beta_1 \text{ (a false-positive, or type I error)},\\
&P(z=0|\omega_{nl}) = 1-\beta_1.
\end{aligned} \tag{1}
$$

.

Therefore, when $z=1$, D is liable with probability

$$p_s = P(\omega_l|z=1) = \frac{p_0(1-\beta_0)}{(1-\beta_0)p_0 + \beta_1(1-p_0)} \tag{2}$$

When $z=0$, D is liable with probability

$$p'_s = P(\omega_l|z=0) = \frac{\beta_0 p_0}{\beta_0 p_0 + (1-p_0)(1-\beta_1)} < p_s \tag{3}$$

In this model, the defendant is perfectly informed of the realization of the state and the victim's signal z. The victim files a claim against the defendant if and only if $z=1$. Therefore, the probability of V filing a claim is the same as the probability that signal $z=1$. Such a probability is determined by the prior probability, p_0, and the errors in the signal as below:

$$P(z=1) = (1-\beta_0)p_0 + \beta_1(1-p_0)$$

After the victim files a claim, a settlement negotiation occurs between the victim and the defendant. In the event of a settlement, the defendant offers a settlement, σ, to the victim. If the victim accepts the settlement offer σ, the defendant transfers the agreed-upon settlement amount σ to the victim, and the case concludes. However, if the victim disagrees with the defendant and rejects the settlement offer σ, then the settlement breaks down, and a trial ensues. If $z=0$, the victim does not file a claim, and there is no litigation. To summarize, the timeline of the development of a case is illustrated in figure 1.

time 0	time 1	time 2	time 3
1. Nature decides the state (ω_l or ω_{nl}) 2. V receives a signal ($z = \{0, 1\}$) regarding the state 3. D observes the realization of the state, as well as V's signal.	1. V files a claim against D if $z = 1$; 2. V does nothing if $z = 0$, and the game ends here.	If $z = 1$, D offers settlement σ to V	V decides whether to accept or to reject σ: 1. If V accepts, D transfers σ to V; 2. If V rejects, a trial occurs.

Figure 1: Timeline of the two-agent game

2.2 Notations

The notations used in the settlement model of this section are listed below.

1. ω – two possible states for defendant D's liability in a case: liable ω_l, or non-liable ω_{nl};
2. z – V's signal about the state: $z = 1$ signals ω_l, $z = 0$ signals ω_{nl};
3. β_0 – the probability of $z = 0$ when the true state is ω_l;
4. β_1 – the probability of $z = 1$ when the true state is ω_{nl};
5. p_0 – V's prior belief of ω_l;
6. p_s – V's belief that D is liable when $z = 1$;
7. p'_s – V's belief that D is liable when $z = 0$;
8. d – damages, which is the same as the amount of fair compensation from a liable D to V for the injury;
9. c_v – V's litigation costs;
10. c_d – D's litigation costs;
11. σ – settlement offered by D to V;
12. x – probability of D offering $\sigma = 0$ when in state ω_l;
13. r – probability of V rejecting an offer of $\sigma = 0$.

2.3 The Settlement Game

A settlement negotiation occurs if the victim, V, files a claim; and V files a claim only when her signal is $z = 1$. Thus, in the settlement game, V's belief that D is liable is p_s, as in equation (2). The settlement game adopts the framework of a standard signaling game (Cho & Kreps, 1987). In this game, there are two types of D – liable and non-liable. V is imperfectly informed of D's type, and D uses the value of σ to signal his type to V. In the separating equilibrium, with some probability, a liable D pretends to be non-liable, and send the signal of being a non-liable type; whereas in a pooling equilibrium, both types of D send the same signal.

In such a game, a settlement is successful if and only if V accepts σ offered by D. V's settlement payoff is the settlement amount σ, and D's settlement payoff is $-\sigma$. If V rejects D's offer of σ, the settlement fails, and a trial occurs. Here, a trial will reveal the true state. For the victim, the court costs are c_v; whereas for the defendant, the court costs are c_d. Thus, V's trial payoff is $d - c_v$ if D is liable, and $-c_v$ if D is not liable; and D's trial payoff is $d + c_d$ if he is liable, and is $-c_d$ if he is not liable. As described in the beginning of this section, the equilibrium value of σ is binary: either 0 or σ^*, where $\sigma^* = d - c_v$.

Note that when the victim is perfectly informed, that is, $\beta_0 = \beta_1 = 0$, V would accept zero settlement offers from a non-liable D with probability 1, and reject zero offers from a non-liable D with probability 1. Therefore, a liable D is better off offering σ^*. Hence, a liable D always offers σ^*, and a non-liable D always offers zero settlement; and V would always accept such settlement offers. Because of this situation, there would be no trial.

To summarize, when V is imperfectly informed ($\beta_0 > 0$ and/or $\beta_1 > 0$), the outcome of the settlement process can be modeled by a signaling game. D's strategy space includes offering two kinds of settlements – a settlement offer of zero or a positive amount, this can be denoted as $\sigma = \{\sigma = 0, \sigma = \sigma^*\}$. There are two actions available to V, accept or reject. If the victim accepts the settlement amount, σ, the settlement is successful, and this settlement amount is transferred from D to V. However, if V rejects settlement σ, then the settlement breaks down, and a trial occurs.

Assumption 1. *A trial will reveal D's true type.*

Admittedly, this assumption is very strong. However, the focus of this paper is the effect of lawyer solicitation, rather than the actual litigation process. In addition, we relax this assumption in section 5.3.

The true state and their own court costs determine D's and V's trial payoffs. The game tree in figure 2 summarizes the settlement game.

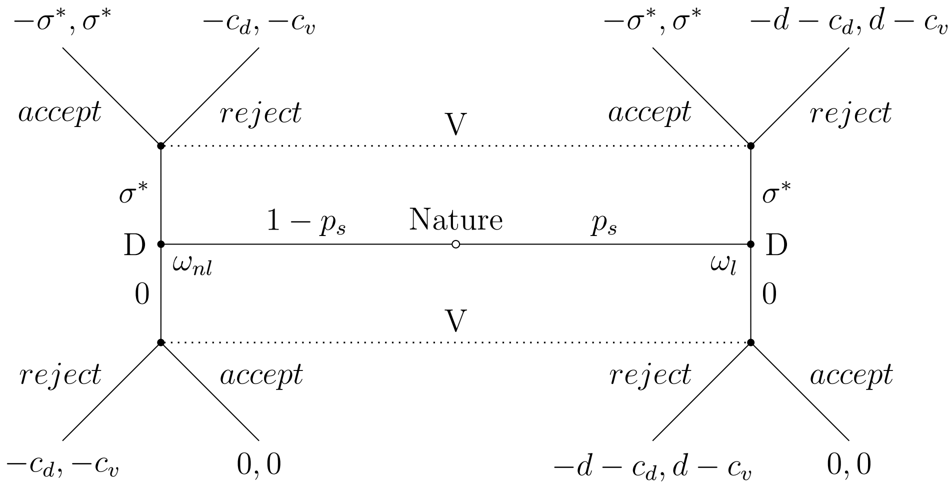

Figure 2: Two-agent signaling game

2.4 Equilibrium Characterization

The strategies of D ($\sigma = 0$ or $\sigma = \sigma^*$) and V (accept or reject) of the signaling game in a settlement negotiation are determined in equilibrium. The solution methods in this model are sequential equilibria.

Assumption 2. *Where there are multiple equilibria, the D1 criterion found in in Cho and Kreps (1987) is applied to refine the results.*[12]

Proposition 1 summarizes the equilibrium results. The detailed calculations are found in Appendix A.

[12] D1 criterion eliminate the pooling equilibria where one type defects whenever the other type defects.

Proposition 1. *(Equilibrium in the two-agent signaling model) When V is imperfectly informed ($\beta_0, \beta_1 > 0$), the equilibrium in the two-agent signaling model when a trial is truth-revealing has the following properties:*

(1) When $p_s \leq c_v/d$, there exists a pooling equilibrium where V is not compensated and there is no litigation.

(2) Litigation occurs if and only if $p_s > c_v/d$. When $p_s > c_v/d$, a non-liable D offers $\sigma = 0$. A liable D offers $\sigma = 0$ with probability x, and $\sigma = d - c_v$ with probability $1 - x$. A settlement is successful when $\sigma = d - c_v$, and a trial occurs when $\sigma = 0$ with probability r. x and r are determined as follows:

$$
\begin{aligned}
x &= \frac{1-p_s}{p_s}\frac{c_v}{d-c_v} = \frac{\beta_1}{1-\beta_0}\frac{1-p_0}{p_0}\frac{c_v}{d-c_v}, \\
r &= \frac{d-c_v}{d+c_d}.
\end{aligned}
$$

(3) V's winning probability in a trial is c_v/d.

Proposition 1(1) suggests that when $p_s d < c_v$, V will never file a claim because V's expected payoff from litigation would not justify her court costs. Such a non-compensation pooling equilibrium can occur when p_s – the proportion of liable cases in all cases filed – is small. By equation (2), when either p_0 – the prior probability that D is liable – is very small, or when V's signal z is very noisy, this non-compensation pooling equilibrium is more likely to occur. This pooling equilibrium can also occur if the damages amount is small relative to the victim's court costs.

Proposition 1(2) suggests that when V's expected payoff from litigation is greater than her court costs, litigation occurs, and there is a separating equilibrium with randomization between a settlement and a trial. For both the two types of D, offering $\sigma = 0$ obtains a higher payoff, and V accepts such a settlement. Therefore, a liable defendant will randomize between the two settlements, $\sigma = 0$ and $\sigma = d - c_v$. In this game, x is the probability of D offering a settlement of zero when liable, and r is the probability of V rejecting an offer of zero, which is equivalent to the probability of the occurrence of a trial.[13]

Proposition 1(3) suggests that the ratio of V's court costs to the damages amount completely determines V's winning probability at trial. The intuition is that if the winning rate is higher than c_v/d, then the expected payoff from a trial would be $p(win)d - c_v > 0$, and V would want to try more cases in court. However, if the winning rate is low and $p(win)d - c_v < 0$, V would want to settle.

In fact, because a trial reveals the true state, such a winning rate is the true proportion of liable cases among the litigated cases. That is, the ratio between the liable cases in rejected zero settlement offers $(xp_s r)$, and the total number of rejected zero-settlement cases $((1 - p_s + xp_s)r)$:

$$\frac{xp_s r}{(1 - p_s + xp_s)r} = c_v/d. \tag{4}$$

3 Three-Agent Model

In reality, a lawyer provides information to affect a victim's legal decision-making in all stages of a case. Lawyers often solicit victim-clients after an accident, and most victims hire lawyers to help them decide whether to litigate their case, which may happen either before or after receiving a defendant's settlement offer. In some types of disputes, lawyers even aid victims in making a decision 100% of the time.[14]

In the model of this section, victims need to be represented by lawyers in the legal process, and thus need to pay lawyers' fees. To isolate the effects of solicitation by a profit-driven lawyer, we assume the following are the only things that the lawyer(L) can do in the game:

Assumption 3. *In this three-agent game, L sends a signal m to V that affects V's belief*

[13] There is a pooling equilibrium whereby $\sigma = pd - c_v$ when $\frac{c_v}{d} < p < \frac{c_v + c_d}{d}$. However, this equilibrium is eliminated by the D1 criterion because whenever liable D wishes to defect, non-liable D wishes to do so as well.

[14] See, e.g. Strickland et. al.,"Virginia Self-Represented Litigant Study," National Center for State Courts, 2017. `https://ncsc.contentdm.oclc.org/digital/collection/accessfair/id/811/`, last accessed Feb.29, 2020.

at the beginning of the signaling game, and charges fees determined by V's choices and the true state.

We further make the following assumptions about the lawyers.

Assumption 4 (Assumptions about L)**.** *(1) L is informed:*

(a) L observes the true state;

(b) L knows the prior p_0, and observes V's private signal, z. Therefore, L knows p_s;

(2) L is entirely profit-driven, and collects the following fees:

(a) a flat fee, f_0, when V files a claim against D;

(b) a flat fee, f, when the there is a court trial;

(c) $(1 - \xi)d$, which is the contingency fee when V wins at trial.

These fees are exogenous to the game.

Admittedly, these assumptions are restrictive. However, the focus of this paper is on studying the effects of solicitation by a profit-driven lawyer on an imperfectly informed victim's litigation choices and welfare; and these assumptions about L are isolate such effects.[15]

If the victim's own noisy signal is $z = 0$, indicating the state is non-liable, a lawyer can strategically send a solicitation $m = 1$ to the victim, which is interpreted as a signal stating that the defendant is liable. The lawyer's optimal signal when $z = 0$ is described in section 3.1. We introduce new notations in section 3.2, and describe the signaling between the victim and the defendant in section 3.3. The signaling equilibrium is described in section 3.4. If the victim's own signal is $z = 1$, she voluntarily hires the lawyer and enters the signaling game if expected payoff is greater than zero. This situation is described in section 3.5. Finally, we describe the lawyer's welfare effects in section 3.6, and provide a

[15]We relax Assumption 4 in subsection 5.1, where L is imperfectly informed, and in subsection 5.3, where L is altruistic.

numerical illustration. The calculations and proofs this section are relegated to Appendix B (for the case when $z = 0$) and Appendix C (for the case when $z = 1$). Assumptions 1 to 4 are assumed in the model of this section.

3.1 The Structure of L's Optimal Solicitation Signal

L is entirely motivated by service fees. When V files a claim, she pays f_0 to L. When V rejects D's settlement offer, automatically leading to a trial, V pays f to L. When a tried case is of the liable type, V wins and pays $(1 - \xi)d$ to L.

As discussed in section 2, the victim will not voluntarily file a claim when she receives the private signal $z = 0$, leading to a belief of p'_s as in (3). L solicits V in this situation. Intuitively, a profit-driven L will want V to file and litigate not only all liable cases but also non-liable cases as well. However, L can only "lie" to a certain degree without losing credibility. In an extreme situation, in equilibrium, if V discovers during litigation that L solicits all cases and thus does not provide her with any information, V would act according her own signal and belief. In contrast, if his signal reflects the true state all the time, then knowing this strategy, the victim becomes perfectly informed. There is some room in-between these two extreme situations where lawyer solicit all liable cases as well as some non-liable cases. Kamenica and Gentzkow (2011) describes the optimal signal in send-receiver game that described the situation here. Such optimal signal achieves the following:

Definition 1 (Optimal Signal)**.** *After updating with the Bayesian optimal signal, V only have two posterior beliefs: whether $\mu_s(\omega_l) = 0$, or $\mu_s(\omega_l) = \mu_t$, where μ_t is the threshold probability for V to file a case.*

That is, after L solicitation, V either believes that D is liable with the threshold probability that is just enough for her to file a claim, or believes D is completely non-liable. V will file a claim in the former, and will not file a claim in the latter. By Kamenica and Gentzkow (2011), since V's actions are binary, under this posterior belief, V takes the sender-optimal action–filing a claim–with the highest probability.

Suppose L sends a signal, $m = \{0, 1\}$. $m = 1$ indicates the defendant is liable; $m = 0$ indicates the defendant is not liable. The following proposition characterizes L's optimal signal according to Definition 1. The proof is in Appendix B.1.

Proposition 2. *(L's optimal solicitation signal) Demote $P(\omega_l) = \mu_0$, $P(\omega_{nl}) = 1 - \mu_0$. V has the correct belief. The threshold belief for V to file a claim is $\mu_t > \mu_0$. Then L's optimal signal is as follows:*

$$\begin{aligned}
&P(m = 1 \mid \omega_l) = 1, \\
&P(m = 0 \mid \omega_l) = 0, \\
&P(m = 1 \mid \omega_{nl}) = \frac{\mu_0}{1 - \mu_0} \frac{1 - \mu_t}{\mu_t}, \\
&P(m = 0 \mid \omega_{nl}) = 1 - \frac{\mu_0}{1 - \mu_0} \frac{1 - \mu_t}{\mu_t}.
\end{aligned} \tag{5}$$

If V's original belief μ_0 is insufficient for her to file a claim ($\mu_0 < \mu_t$), for suitable costs, V follows the recommendation for L under L's optimal signal structure as described in Proposition 2. This decision rule of V is termed *Obedience* in (Bergemann & Morris, 2016). Analysis in section 2 suggests that Proposition 2 applies when $\mu_0 = p'_s < \mu_t$, that is, when $z = 0$. We will discuss this situation in subsection 3.4. When $z = 1$, $\mu_0 = p_s > \mu_t$. In this case, V hires L voluntarily without solicitation. This situation is described in subsection 3.5.

3.2 Additional Notations

To develop the three-agent model, we first introduce some new notations. The additional notations required for the three-agent signaling game are listed below.

1. m – the signal from L to V if $z = 0$. $m = 1$ denotes L's solicitation;
2. f_0 – V's flat payment to L if V files a claim;

3. f – the flat court trial fee paid to L when V rejects D's settlement offer and a trial occurs;
4. ξ – the portion of d that V keeps if she wins at trial, after paying $(1-\xi)d$ to L as contingency fee;
5. μ_s – when $z = 1$, V's posterior belief after L's signal; the specific meaning of μ_s depends on the context;
6. μ_s' – when $z = 0$, V's posterior belief after L's signal; the specific meaning of μ_s' depends on the context;
7. μ_t – the threshold $P(\omega_l)$ for V to file a suit;
8. $\bar{p}$ – the proportion of liable cases in settlement when $z = 0$ and $m = 1$;
9. p – the proportion of liable D in a signaling game used in the game tree.

3.3 The Three-Agent Signaling Game

In the model, V first gets her own signal $z = \{0, 1\}$. When $z = 1$, V hires L and files a claim against D without any solicitation signal from L. If $z = 0$, L sends a signal $m = \{0, 1\}$ to V. V hires L and files a claim against D if $m = 1$; this reflects the lawyer's solicitation. If V files a claim, V and D enter a settlement game. The timeline of this model is shown in figure 3.

time 0	time 1	time 2	time 3
1. Nature decides the state (ω_l or ω_{nl}) 2. V receives a signal ($z = \{0, 1\}$ regarding the state 3. D and L observe the realization of the state, as well as V's signal, z.	1. L sends a signal $m = \{0, 1\}$ to V if $z = 0$; 2. V hires L if $m = 1$ or if $z = 1$, and files a claim against D. 3. V does nothing if $z = 0$ and $m = 0$, and the game ends here.	If $z = 1$ or $m = 1$ (when V files a case), D offers settlement σ to V.	V decides whether to accept or to reject σ: 1. If V accepts, D transfers σ to V; 2. If V rejects, a trial occurs which reveals the true state.

Figure 3: Timeline of the three-agent game

If $z = 0$, the three-agent signaling model in this section solves L's optimal information disclosure in the signaling equilibrium. There are two steps in the signaling game. First, L strategically sends a signal m to V whenever V's private signal $z = 0$. Thus L determines the proportion of liable D's in the game.[16] This is V's prior belief of ω_l in this Bayesian game. Second, the signaling between V and D are carried out. Here, Assumption 1 applies, and therefore litigation is assumed to reveal the true state.[17] If $z = 1$, we only need the second step in the game.

Given L's fee structure, L also affects V's payoffs in the game in the second step. The settlement offer σ from D changes accordingly. When interacting with a liable D, V's settlement payoff is $\sigma - f_0$, and the trial payoff is $\xi d - f_0 - f - c_v$. Therefore, the lowest settlement that V would accept is $\sigma = \xi d - f - c_v$. When interacting with a non-liable D, V's settlement payoff is $\sigma - f_0$, and the trial payoff is $-c_v - f - f_0$. Thus, the lowest non-negative settlement that V would accept is 0. We denote $\sigma^* = \xi d - f - c_v$. D's strategy is $\sigma = \{\sigma^*, 0\}$, and V's strategy is to either accept or reject.

The game tree found in figure 4 summarizes the game with lawyerly representation. The node L means that L affects V's belief when entering the game. When $z = 1$, L does not affect the V's belief, and thus $p = p_s$. When $z = 0$, p represents $mu'_s(m = 1, z = 0)$ in section 3.4.

[16] Each signal realization leads to a distribution $\Delta(\Omega)$ over posterior beliefs. Thus, given any signal, the distribution of posterior belief is $\tau \in \Delta(\Delta(\Omega))$. A sender can effectively choose any posterior belief μ_s for the receiver, as longs the expectation of the posterior beliefs induced by a signal is same as the prior belief μ_0, i.e. $\sum_{\text{supp}(\tau)} \mu_s \tau(\mu_s) = \mu_0$. See (Kamenica & Gentzkow, 2011).

[17] Proposition 9 shows that Bayesian persuasion of L and D toward a judge reveals the true state in litigation.

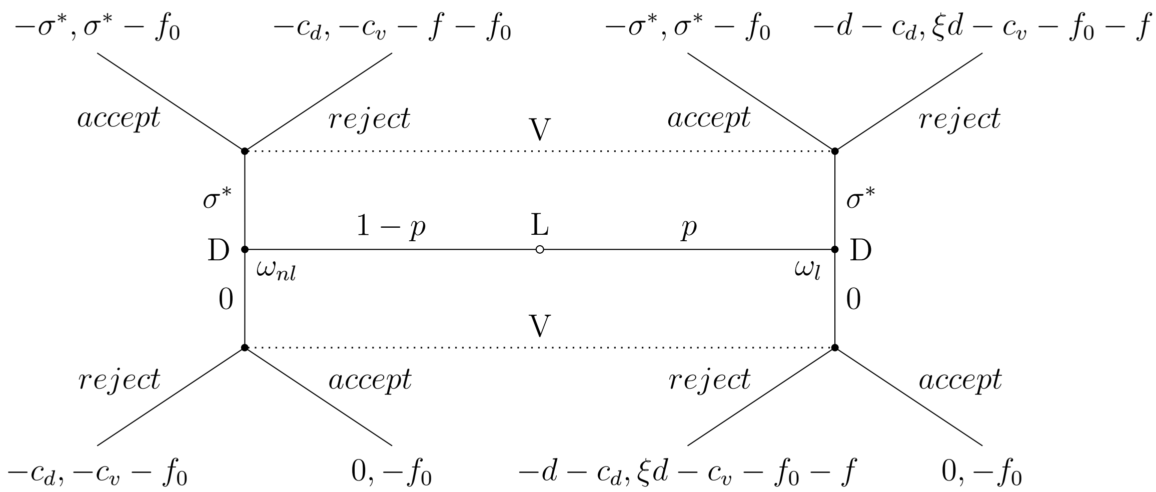

Figure 4: Three-agent signaling game

Notice that when $z = 1$, $p = p_s$. When $z = 0, m = 1$, $p = \bar{p}$.

3.3.1 Equilibrium Characterization

Given the cost of a lawyer's representation, a victim would only hire a lawyer when the expected payoff from litigation or the settlement would justify the lawyer's fees. In other words, we would have the following.

1. When $z = 0$, and when $m = 1$, V would accept L's solicitation and file a case. She believes that D is liable with probability $\mu_s(z = 0, m = 1)$, where $\xi d\mu_s'(z = 0, m = 1) - f - f_0 - c_v \geq 0$. For $0 < \mu_s'(z = 0, m = 1) < 1$, we must require $\xi d - c_v - f - f_0 > 0$.

2. When $z = 1$, V believes D is liable with probability p_s. V would hire L when the cost is justified, meaning $\xi dp_s - f - f_0 - c_v \geq 0$.

Next, subsection 3.4 discusses L's solicitation $z = 0, m = 1$, and subsection 3.5 studies the effect of the addition of L on the equilibrium when $z = 1$.

3.4 Lawyer's Solicitation ($m = 1$) When $z = 0$, $\xi d - c_v - f - f_0 > 0$

When the victim is unaware of the injury or the legal resources available to her ($z = 0$), a lawyer's solicitation ($m = 1$) provides such relevant information to her and motivates her to file a case. The lawyer's incentive is to encourage as many case filings and and as much litigation as possible without losing credibility. L uses the signal as described in proposition 2. V's posterior belief after receiving L's signal is as follows.

$$\mu'_s(\omega_l|m=1, z=0) = \frac{c_v + f + f_0}{\xi d} = \mu_t,$$
$$\mu'_s(\omega_l|m=0, z=0) = 0.$$

Since $0 < \mu_t < 1$, $0 < c_v + f + f_0 < \xi d$. The signaling equilibrium determines L's specific information disclosures and V's litigation decisions.

Proposition 3. *(V's belief after L's solicitation) When $m = 1$, V believes D is liable with the threshold probability for her to file a case, which is $\mu'_s(\omega_l|m = 1, z = 0) = \mu_t = \bar{p} = \frac{c_v+f+f_0}{\xi d}$; when $m = 0$, V believes that D is completely non-liable, $\mu'_s(\omega_l|m = 0, z = 0) = 0$. In this case, V files the maximum number of cases possible given the prior belief p'_s.*

V files a case when $m = 1$. Therefore among the cases filed, the probability that D is liable is

$$\bar{p} = \mu'_s(\omega_l|m = 1, z = 0) = \frac{c_v + f + f_0}{\xi d}. \tag{6}$$

V's decisions in the settlement game is summarized below.

Proposition 4. *(V's and D's strategies in a three-agent signaling equilibrium after L's solicitation)*

(1) V hires L only when $\xi d - c_v - f - f_0 > 0$.

(2) In such a case, there is only a separating equilibrium where,

(i) if non-liable, D offers zero settlement and there is no trial;

(ii) if liable, D randomizes between two offers: zero with probability

$$x = \frac{1-\bar{p}}{\bar{p}} \frac{c_v + f}{\xi d - c_v - f} = \frac{\xi d - c_v - f - f_0}{\xi d - c_v - f} \frac{c_v + f}{c_v + f + f_0}.$$

and a positive settlement amount,

$$\sigma^* = \xi d - c_v - f$$

with probability 1-x;

(iii) V accepts positive offer σ^*, and rejects zero offers with probability

$$r = \frac{\xi d - c_v - f}{d + c_d}$$

Appendix B provides a detailed calculation of the results for Propositions 3 and 4.

3.4.1 Effect of L's Solicitation

Because V does not file a claim without L when $z = 0$, the claims filed due to L's solicitation is a net increase of the total claims filed. L increases the total number of cases filed by

$$\begin{aligned} &P(z=0) * (p'_s + P(m=1 \mid \omega_{nl})(1-p'_s)) = P(z=0)p'_s \frac{\xi d}{c_v + f + f_0} \\ &= \beta_0 p_0 \frac{\xi d}{c_v + f + f_0}. \end{aligned} \tag{7}$$

The trial probability if the case is filed is

$$(1 - \bar{p} + x\bar{p})r = \frac{\xi d - c_v - f - f_0}{d + c_d}$$

Thus, the number of trials increased is the product of the above two equations:

$$\begin{aligned} &P(z=0) * (p'_s + P(m=1 \mid \omega_{nl})(1-p'_s)) * (1 - \bar{p} + x\bar{p})r \\ &= \beta_0 p_0 \frac{\xi d}{c_v + f + f_0} \frac{\xi d - c_v - f - f_0}{d + c_d} \end{aligned} \tag{8}$$

The probability of winning at trial here is also higher than the probability of winning in the two-agent equilibrium without a lawyer discussed in section 2:

$$\frac{x\bar{p}}{1-\bar{p}+x\bar{p}} = \frac{c_v+f}{\xi d} > \frac{c_v}{d}. \tag{9}$$

Further, there is no pooling equilibrium in this three-agent signaling game.

3.5 Legal Representation When $z = 1$ and $\xi d p_s \geq c_v + f + f_0$

When $z = 1$, V would voluntarily file a case against D; thus, solicitation from L is unnecessary, and V would receive no signal from L. However, if L represents V, L eliminates the possible pooling equilibrium and also increases V's trial winning rate. Incentive compatibility requires that V hires L only when $\xi d p_s \geq c_v + f + f_0$.

The following proposition characterizes the equilibrium.

Proposition 5. *(Equilibrium in the three-agent model when $z = 1$)*

(1) V only hires L when $\xi d p_s \geq c_v + f + f_0$.

(2) There is only a separating equilibrium where,

(a) if non-liable, D offers zero settlement;

(b) if liable, D randomizes between two offers: zero with probability

$$x = \frac{1-p_s}{p_s}\frac{c_v+f}{\xi d - c_v - f} = \frac{1-p_0}{p_0}\frac{\beta_1}{1-\beta_0}\frac{c_v+f}{\xi d - c_v - f},$$

and a positive settlement amount,

$$\sigma^* = \xi d - c_v - f$$

with probability $1 - x$.

(c) V accepts positive offers σ^*, and rejects zero offers with probability

$$r = \frac{\xi d - c_v - f}{d + c_d}.$$

3.5.1 Effect of Being Represented by L

A trial occurs when V rejects D's zero offers. The probability of a trial is:

$$P(z = 1) * (1 - p_s + xp_s)r = (1 - p_s)\frac{\xi d}{d + c_d}P(z = 1). \tag{10}$$

The probability of winning at trial is

$$\frac{xp_s}{1 - p_s + xp_s} = \frac{c_v + f}{\xi d}. \tag{11}$$

3.6 The Welfare Effects of Lawyer's Solicitation

Lawyer's solicitation is more likely to be successful when the stakes of V in the case is high relative to lawyer's costs, and when V's private signal is noisy in a certain way. Specifically,

Proposition 6. *V is more likely to hire L under the following conditions:*

(1) When the cost of hiring L is relatively low, and the damages amount, d, is relatively high, or

(2) When V's private signal, z, is conducive to hiring L. Specifically,

(a) when $z = 0$, if V is more likely to fail to recognize a liable case;

(b) when $z = 1$, if V's signal is more precise.

Overall, L's solicitation when $z = 0$ helps V to recognize more liable cases, and at the same time, sends more non-liable cases into litigation. When L represents V in litigation, the cases at trial here are more likely to be liable compared to those discussed in Section

2, and thus, V's trial winning rate becomes higher. There is no pooling equilibrium when L represents V. However, a lawyer's representation is costly, and it reduces the net compensation award, from $d - c_v$ to $\xi d - c_v - f - f_0$. Furthermore, many victims in non-liable cases still file cases and some even go to trial. These victims pay lawyers fees and get no compensation.

Based on the results from the two-agent and three agent models, we propose the following results.

Proposition 7. *(L's welfare effect is ambiguous) L adds value in the following ways:*

(1) Under appropriate conditions, L helps V recognize liable cases and help her get compensated in the following ways:

   (a) L claims filed in the amount of $\beta_0 p_0 \frac{\xi d}{c_v + f + f_0}$*;*

   (b) if V hires L, the pooling equilibrium where V is not compensated is eliminated.

(2) L increases the overall trial winning rate from $\frac{c_v}{d}$ *to* $\frac{c_v + f}{\xi d}$*;*

(3) However, lawyers also increase case filings and trials in non-liable cases, and this reduces a victim's net payoff in litigated cases after considering lawyer's fees.

The numerical example in the next subsection illustrates such ambiguous welfare effects.

3.6.1 Numerical Example to Illustrate Proposition 7

We use a numerical example to illustrate Proposition 7. The calculation are based on Propositions 1,3,4,5. The detailed calculation for this example is in Appendix C.5.

Consider the situation where a collection of victims (V) is injured when interacting with a collection of defendants (D), and each injury leads to a medical bill of \$1000. Each V interacts with one D and wants D to compensate her for the medical expenses. However, each V is not sure whether the particular D she faces is liable. Litigation is costly – the court costs for V are \$50, and are \$100 for D.

Assume there are 1000 such injuries in total. It is common knowledge that D is liable for 100 of the injuries, and not liable for 900 of them. This suggests $p_0 = 0.1$. When D is actually liable, V knows with probability 0.7 ($\beta_0 = 0.3$). When D is not liable, V mistakenly believes D is liable with probability 0.1 ($\beta_1 = 0.1$).

Without lawyers, among the 100 liable cases, victims obtain a settlement of \$950 in 65 of them, and they win around 5 of them in court trials to obtain \$950. There are 160 total cases filed, and around 82 of them go trials, and V's trial winning rate is around 6%.

Assume that lawyers (L) approach V. L gets \$20 when V sues D, an additional \$100 if the case goes to trial, as well as 30% of V's damages award if V wins at trial (\$1000∗30% = \$300). When represented with lawyers, the victims obtain a settlement of \$550 in around $45 + 5 = 50$ of the 100 liable cases, and win around $12 + 13 = 25$ cases in court trials to obtain \$550. In aggregate, around 75 victims receive compensation in the amount of 530 after factoring in the lawyers initial fee of f_0. In total, there are $160 + 124 = 284$ cases filed, $57 + 60 = 117$ court trials, and the winning rate at trial is 21%. V loses in $117 - 25 = 92$ cases, where they must pay \$70 to L. In $58 + 59 = 117$ cases, V pays consultation fees of \$20 to L.

This example show that lawyers help most victims in liable cases get compensation, and they increase litigation. However, lawyers are costly, which reduces the net award to the victims who obtain compensation. Lawyers increase total number of cases filed as will as the total number of ligation. Therefore, many more victims in non-liable cases also hire lawyers and litigate, resulting in a net payment to lawyers.

4 L's Effect on D's Endogenous Safety Costs and Prior Liability

This section analyzes the lawyer's effect of regulating the defendant's precaution level. In this setting, the defendant's prior probability of being liable, p_0, is an endogenous function of his safety costs, y, which are the costs associated with taking precautions to avoid injury to others. For simplicity, the following functional form is used:

$$p_0 = \frac{1}{y+1} \tag{12}$$

Thus, p_0 is a convex, decreasing function of y. When $y = 0$, $p_0 = 1$; and when $y \to \infty$, $p \to 0$. This function shows that if the total safety costs are 0, the defendant is definitely liable; increasing the safety costs decrease the defendant's prior probability of being liable, but the marginal effect of such a reduction decreases:

$$p_0' = -\frac{1}{(1+y)^2} < 0, \quad p_0'' = \frac{2}{(1+y)^3}.$$

The safety costs must approach infinity to reduce the prior probability in order to be close to 0. A defendant chooses the optimal level of safety costs y by balancing safety investments and the expected expenditure he would incur in litigation.

When both the victim and the defendant are completely informed, a liable defendant's payoff from a court trial is $-d - c_d$, so he would prefer to pay a settlement of $d - c_v$ to V. Because V would not obtain more from a trial, she would accept such a settlement. V would not file a claim against a non-liable D, as her payoff from a court trial would be $-c_v$, and D would only offer a settlement of 0 to V. Thus, there is no trial, and D offers a settlement of $d - c_v$ if and only if he is liable. D solves the following problem to minimize his expected cost:

$$\begin{aligned} &\min_y \; p(d - c_v) + y \\ &s.t. p = \frac{1}{y+1}, y > 0, 1 > p > 0 \end{aligned} \tag{13}$$

Let p_0^* and y^* be D's equilibrium safety cost and prior probability of being liable, respectively. From the first order condition, we get

$$y^* = \sqrt{d - c_v} - 1, \quad p_0^* = \frac{1}{\sqrt{d - c_v}}.$$

The following subsections discuss the defendant's problem in the signaling games when a victim only have incomplete information regarding whether a defendant is liable.

4.1 Two-Agent Signaling Game

We consider the setting of the baseline two-agent signaling game discussed in section 2. The defendant is perfectly informed, but the victim only obtains a noisy signal. There are two cases: the pooling equilibrium with no litigation, and separating equilibrium with some litigation. Denote the equilibrium safety cost $y^{'**}$ in the first case, and y^{**} in the second case. Let p_0^{**} the D's equilibrium prior probability of being liable.

4.1.1 Case 1: Pooling Equilibrium with No Litigation

In order to avoid litigation entirely, by proposition 1, the following condition must be satisfied:

$$p_s < \frac{c_v}{d}.$$

We substitute in p_s from equation (2), and obtain the following restriction on y:

$$\begin{aligned}
&\frac{p_0(1-\beta_0)}{(1-\beta_0)p_0 + \beta_1(1-p_0)} < \frac{c_v}{d} \\
\Longrightarrow\ & p_0 < p_0^{'**}, p_0^{'**} = \frac{\beta_1 c_v}{(1-\beta_0)(d-c_v) + \beta_1 c_v} \\
\Longrightarrow\ & y > y^{'**}, y^{'**} = \frac{1-\beta_0}{\beta_1}\frac{d-c_v}{c_v}.
\end{aligned}$$

Such safety costs can be quite high if $d \gg c_v$ or when $\beta_1 \to 0$ – that is, when V can almost perfectly recognize liable cases. In fact, $y^{'**} \to \infty$ and $p_0 \to 0$ if $\beta_1 \to 0$.

4.1.2 Case 2: Separating Equilibrium with Randomization in Litigation

Considering the safety costs, we can see from case 1 that litigation is practically inevitable when V can recognize nearly all liable cases, as this this requires very high safety costs, $\lim_{\beta_1 \to 0} y^{'**} = \infty$. Suppose there is litigation. The defendant's minimization problem is as follows:

$$
\begin{aligned}
&\min_{y}\ p_0(1-\beta_0)\left[xr(d+c_d)+(1-x)(d-c_v)\right]+(1-p_0)\beta_1 r c_d+y\\
&s.t. p_0=\frac{1}{y+1} \qquad (14)\\
&\quad 0<p_0<1, y>0.
\end{aligned}
$$

We substitute in r, x from Section 2, proposition 1. Thus, the defendant solves the following for $0<p_0<1$:

$$
\begin{aligned}
&\min_{p_0}\ p_0(1-\beta_0)\left[\frac{\beta_1}{1-\beta_0}\frac{1-p_0}{p_0}c_v+d-c_v-\frac{\beta_1}{1-\beta_1}\frac{1-p_0}{p_0}c_v\right]+(1-p_0)\beta_1\frac{d-c_v}{d+c_d}c_d+\frac{1}{p_0}-1\\
=&\min_{p_0}\ p_0(1-\beta_0)(d-c_v)+(1-p_0)\beta_1\frac{d-c_v}{d+c_d}c_d+\frac{1}{p_0}-1\\
=&\min_{p_0}\ p_0(d-c_v)\left[1-\beta_0-\frac{c_d}{d+c_d}\beta_1\right]+\frac{1}{p_0}-1+\frac{d-c_v}{d+c_d}\beta_1 c_d.
\end{aligned}
$$

By first order condition, we get

$$
\begin{aligned}
p_0^{**}&=\frac{1}{\sqrt{(d-c_v)(1-\beta_0-\frac{c_d}{d+c_d}\beta_1)}}>\frac{1}{\sqrt{d-c_v}}=p_0^*\\
y^{**}&=\sqrt{(d-c_v)(1-\beta_0-\frac{c_d}{d+c_d}\beta_1)}-1<\sqrt{d-c_v}-1=y^*.
\end{aligned}
$$

There is no litigation when both V and D are completely informed. However, avoiding litigation entirely might not be possible when V is not perfectly informed. When there is litigation, $y^{**}<y^*$, and $p_0^{**}>p^*$. Thus, when the victim is imperfectly informed, the defendant's optimal safety costs will be lower, and the optimal probability of prior liability will be higher.

4.2 Three-Agent Signaling Game

We denote the defendant's equilibrium safety costs and prior probability of being liable as y^{***} and p_0^{***}, respectively. For litigation with lawyerly representation to occur, the following must hold.

$$\xi d - c_v - f - f_0 > 0.$$

If the above is satisfied, then there is always litigation. We then apply the results found in section 3 for the three-agent game for the separating equilibrium with randomization. The defendant's problem is as follows:

$$\min_{p_0} p_0 \left[1 - \beta_0 + \beta_0\right] \left[xr(d + c_d) + (1 - x)(\xi d - c_v - f)\right] +$$
$$+ (1 - p_0) \left[\beta_1 + (1 - \beta_1) \frac{\beta_0}{1 - \beta_1} \frac{p_0}{1 - p_0} \frac{\xi d - c_v - f - f_0}{c_v + f + f_0}\right] xrc_d + \frac{1}{p_0} - 1.$$

Substitute in x, r,

$$\min_{p_0} p_0(\xi d - c_v - f) + (1 - p_0) \left[\beta_1 + \beta_0 \frac{p_0}{1 - p_0} \frac{\xi d - c_v - f - f_0}{c_v + f + f_0}\right] \frac{\xi d - c_f - f}{d + c_d} c_d + \frac{1}{p_0} - 1.$$

By solving the first order condition and restricting $0 < p_0 < 1$, we get the following.

$$p_0^{***} = \frac{1}{\sqrt{\xi d - c_v - f}} \frac{1}{\sqrt{1 + \left(\beta_0 \frac{\xi d - c_v - f - f_0}{c_v + f + f_0} - \beta_1\right) \frac{c_d}{d + c_d}}} > \frac{1}{\sqrt{\xi d - c_v - f}},$$
$$y^{***} = \sqrt{\xi d - c_v - f} \sqrt{1 + \left(\beta_0 \frac{\xi d - c_v - f - f_0}{c_v + f + f_0} - \beta_1\right) \frac{c_d}{d + c_d}} - 1 > \sqrt{\xi d - c_v - f} - 1.$$

L's effects on D's safety costs and the prior probability of being liable is ambiguous. If V is unlikely to mistake a liable defendant for a non-liable one, the presence of a lawyer actually increases the prior probability of D being liable, as L's fees make a court trial less likely. When a victim is more likely to mistake a liable case for a non-liable one, and when the lawyers' flat case filing fee is sufficiently low, the presence of the lawyer increases the defendant's precaution cost, and thus, decreases the defendant's prior probability of being liable.

Proposition 8. *L's effects on D's safety costs, and thus, the prior probability of being liable, depend on specific parameters.*

Proof. Compare the two-agent signaling game and the three-agent signaling game.

$$\left(\frac{p_0^{**}}{p_0^{***}}\right)^2 = \frac{\xi d - c_v - f}{d - c_v} \frac{1 - \beta_1 \frac{c_d}{d+c_d} + \beta_0 \frac{\xi d - c_v - f - f_0}{c_v + f + f_0} \frac{c_d}{d+c_d}}{1 - \beta_1 \frac{c_d}{d+c_d} - \beta_0}$$

In reality, it is quite possible that $d \gg c_d$ and $d \gg c_v$, thus

$$\left(\frac{p_0^{**}}{p_0^{***}}\right)^2 \to \frac{\xi d - f}{d} \frac{1}{1 - \beta_0}$$

Therefore,

$$p_0^{**} > p_0^{***} \iff f < (\beta_0 - (1 - \xi))d$$

In reality, $0.33 < 1 - \xi < 0.4$. [18] Suppose $1 - \xi = 0.4$. If $0 < \beta_0 < 0.4$, then the right-hand side is less than 0, and thus $p_0^{***} > p_0^{**}$. That is, when the victim do not make much type II mistake, and recognize most liable cases, the presence of the lawyer actually increases the defendant's prior probability of being liable. In such situation, D's safety costs are decreased.

However, if $0.4 < \beta_0 < 1$, then $p_0^{***} < p_0^{**}$ if and only if $f < (\beta_0 - (1 - \xi))d$. In reality, when a lawyer charges a contingency fee, there is usually no flat case filing fee, that is $f = 0$. In such situations, when the victim makes a type II error and mistakes a liable case for a non-liable case sufficiently often (i.e.$1 \geq \beta_0 > 1 - \xi$), the presence of a lawyer increases the precaution cost of the defendant. □

Thus, the presence of a lawyer may increase D's safety costs and decrease D's prior probability of being liable, but may also do the opposite. The intuitions is that a lawyer has two effects: (1) helps a victim recognize liable cases; (2) increases a victim's litigation costs. The first effect encourages litigation and thus increases D's safety costs and reduces D's prior probability of being liable; and the second effect does the opposite. The lawyer's overall effect depends on the strength of the two opposing effects, which in turn depends

[18] Lawyer's contingency fees are usually between 33% and 40%. For example, see "Lawyers' Fees in Your Personal Injury Case", `https://www.alllaw.com/articles/nolo/personal-injury/lawyers-fees.html`, last access March 1, 2020.

on the specific parameters.

5 Three Extensions

Next, we consider three extensions to the three-agent model: (1) a lawyer's solicitation when he is imperfectly informed, (2) a lawyer solicitation when he is altruistic, and (3) persuasion during litigation where the defendant is able to persuade the judge.

5.1 Extension 1: Solicitation by an Imperfectly Informed L

This extension weakens the assumption that L is completely informed. The assumptions regarding L's information and signaling strategy are as follows.

(1) L is imperfectly informed before being hired:

   (a) L's prior belief that a case is liable is p_0. L gets a noisy signal, s:

$$P(s=1|\omega_l) = 1-\theta_0$$

$$P(s=0|\omega_l) = \theta_0 \text{ (a false-negative, or a type II error)}$$

$$P(s=1|\omega_{nl}) = \theta_1 \text{ (a false-positive, or a type I error)}$$

$$P(s=0|\omega_{nl}) = 1-\theta_1;$$

   (b) L observes V's signal z;

   (c) L's signal is better than V's signal: $\theta_0 < \beta_0$, $\theta_1 < \beta_1$;

(2) L conditions his optimal signaling strategy $m = \{0, 1\}$ on s:

$$P(\omega, m \mid s) = P(\omega \mid s)P(m \mid s)$$

Therefore, the state ω and L's signal m are mutually independent, conditional on L's signal s. Intuitively, L can distinguish the states ω_l and ω_{nl} only as well as his signal,

s. If L's signal is $s = 1$, he tells V that D is liable; and if L's signal is $s = 0$, with some probability, he tells V that L is liable.

(3) L becomes fully informed if hired. Thus, the equilibrium when $z = 1$ is not affected, as V voluntarily hires L in such a situation.

The next sub-subsection presents the equilibrium of this setup. The detailed calculations are provided in Appendix D.

5.1.1 Equilibrium Characterization

(1) L's signaling strategy is as follows:

$$
\begin{aligned}
&P(m = 1|s = 1) = 1, \\
&P(m = 0|s = 1) = 0, \\
&P(m = 1|s = 0) = \frac{\xi d(1-\theta_0)p'_s - (c_v + f + f_0)[(1-\theta_0)p_0 + \theta_1(1-p_0)]}{(c_v + f + f_0)[\theta_0 p_0 + (1-p_0)(1-\theta_1)] - \xi d\theta_0 p'_s}, \\
&P(m = 0|s = 0) = \frac{c_v + f + f_0 - \xi d p'_s}{(c_v + f + f_0)[\theta_0 p_0 + (1-p_0)(1-\theta_1)] - \xi d\theta_0 p'_s}.
\end{aligned}
$$

(2) V's and D's signaling equilibrium is as follows:

The signaling equilibrium in terms of V's and D's strategies and V's beliefs are exactly the same as those in section 3. In fact, L chooses the signal that results in the same signaling equilibrium as that in the perfect information situation.

5.1.2 The Imperfectly Informed L's Effects

The winning rate from a trial is still $\frac{c_v+f}{\xi d}$. Given the signaling equilibrium characterized in subsection 3.3, the amount of claims filed increases by:

$$P(m=1)*P(z=0)=\frac{\xi dp'_s(1-p_0)(1-\theta_0-\theta_1)}{[\theta_0p_0+(1-p_0)(1-\theta_1)](c_v+f+f_0)-\xi d\theta_0p'_s}*P(z=0),$$
$$=\frac{\xi d\beta_0p_0(1-p_0)(1-\theta_0-\theta_1)}{[\theta_0p_0+(1-p_0)(1-\theta_1)](c_v+f+f_0)-\xi d\theta_0p'_s}. \tag{15}$$

When $\theta_1=\theta_0=0$, the number of cases filed is $\frac{\xi dp'_s}{c_v+f+f_0}$. This is the situation when L is fully informed. When $\theta_0,\theta_1\in(0,0.5)$, $P(m=1)<\frac{\xi dp'_s}{c_v+f+f_0}$.[19] Thus, the number of cases filed after a lawyer's solicitation when L is imperfectly informed is fewer than that when L is perfectly informed.

The probability of a court trial increases by:

$$\begin{aligned}&P(z=0)P(m=1)(1-\bar{p_v}+x\bar{p_v})r\\&=P(z=0)P(m=1)\frac{\xi d-c_v-f-f_0}{d+c_d}.\end{aligned} \tag{16}$$

Proposition 9. *An imperfectly informed L can also increase litigation. The effectiveness of L's solicitation increases as L becomes more informed. When L becomes increasingly more informed, the equilibrium converges to the three-agent case where L is completely informed as in section 3.*

Proof. Compare the probability of number of case filings increase by L here (in equation (18)) to that in Section 3 (in equation (9)), we find that there is an additional term $0\le P(m=1)\le 1$ here, where

$$P(m=1)=\frac{\xi dp'_s(1-p_0)(1-\theta_0-\theta_1)}{[\theta_0p_0+(1-p_0)(1-\theta_1)](c_v+f+f_0)-\xi d\theta_0p'_s}>0.$$

The detailed calculations are shown in Appendix D. Therefore, we see that L can always increase the amount of litigation, although to a lesser extent compared to the situation where L is perfectly informed. If L is almost perfectly informed, then $\theta_0=\theta_1=0$, and $P(m=1)=\frac{\xi dp'_s}{c_v+f+f_0}$, and the number of cases increased is the same as the

[19] $\theta_i=0.5, i=0,1$ is the completely uninformed case.

perfectly informed L setting in equation (8). □

5.2 Extension 2: Solicitation by Altruistic Lawyers

In reality, L's personal and professional ethics may require him to be concerned about V's payoff. Moreover, L may value his reputation, which depends on how much he can help V. Therefore, L derives utility from both his profit and V's payoff:

$$U_L = (1-\delta)\pi_L + \delta\pi_V, \quad \delta \in [0,1].$$

Such internalization of the other party's utility is labeled "altruism". Altruism need not be driven by pure emotion. The parameter δ captures the degree of L's altruism.

Proposition 10. *There is a threshold degree of altruism that determines L's action. If L is more altruistic than the threshold level, he will always report the truth to V, thus eliminating a court trial. Otherwise L acts as if he is entirely profit-driven.*

Proof. This Proposition easily follows the equilibrium of a three-agent game with an altruistic lawyer, presented in the below. Detailed calculations are found in Appendix E. We can find a threshold degree of altruism,

$$\delta^* = \frac{1}{1+\kappa},$$
$$\kappa = \frac{c_v + f + f_0}{f_0 + \frac{1}{1+\frac{c_d}{d}}(f + (1-\xi)c_v)},$$

such that

(i) when $\delta \geq \delta^*$, L truthfully report the state to V. The signal from L to V, then, is the following:

$$P(m=1|\omega_l) = 1, \quad P(m=0|\omega_l) = 0,$$

$$P(m=1|\omega_{nl}) = 0, \quad P(m=0|\omega_{nl}) = 1.$$

Thus, this game is equivalent to the two-agent perfect information game, where

V files a suit against D whenever D is liable, and D provides positive settlement $\sigma^* = \xi d - c_v - f - f_0$ to V whenever V sues him. There are no court trials;

(ii) when $\delta < \delta^*$, the equilibrium is the same as that found in section 3.

□

5.3 Extension 3: Bayesian Persuasion in a Court Trial

In this subsection, a trial does not necessarily reveal the truth. Instead, a judge (J) makes a binary decision, liable or non-liable, based on his belief and a certain threshold standard. In the two-agent signaling game, where informed defendants can manipulate the judges' decisions in trials by using the optimal signal characterized in proposition 2 to persuade J, victims will lose many trials in cases where defendants are liable in equilibrium. However, with the addition of a lawyer, the persuasion from L and D causes a trial to reveal the truth.

5.3.1 Two-Agent Model when Litigation Does Not Reveal the True State

In an actual trial, a judge considers information and the arguments supplied by both sides and determines the case outcome. This subsection assumes that in a trial, J shares V's prior, $\mu_0(\omega_l) = p_s$, and that D sends a signal to affect J's belief. J makes a decision based on his posterior belief and a decision standard. For example, if J adopts a "more likely than not" criterion, J rules D liable if and only if he believes that D is liable with a probability higher than 50%. However, if J is more pro-defendant, then the threshold probability becomes higher.

5.3.2 J's Decision Rule and D's Optimal Signal in A Trial

In a trial, J derives zero utility when he makes a correct decision, and derives a negative utility when he makes a wrong decision. Normalizing the utility from wrongfully ruling against a non-liable D to be 1, J's utility from ruling is:

$$\begin{aligned} u(V\ wins|\omega_l) &= 0, \quad u(V\ wins|\omega_{nl}) = -1, \\ u(D\ wins|\omega_l) &= -\gamma, \quad u(D\ wins|\omega_{nl}) = 0. \end{aligned} \tag{17}$$

The persuasion setting here between D and J is analogous to that between L and V described in proposition 2. We assume J takes a sender-optimal action when J is indifferent. J's action $\hat{v}(p_s)$ is binary: J will rule against V if $p_s = \mu_0(\omega_l) \leq \frac{1}{\gamma+1}$, and will rule against D if $p_s > \mu_0(\omega_l) < \frac{1}{\gamma+1}$. Thus, D only benefits from persuasion when $p_s > \frac{1}{\gamma+1}$.

Two new variables are introduced into the two-agent baseline model to capture the effect of J's decision rule on the signaling equilibrium:

1. α – V's trial winning probability for a liable case;
2. β – V's trial winning probability for a non-liable case (as we will see later, $\beta = 0$).

Let $\mu_0(\omega_l)$ be the probability of D being liable in a trial. In the two-agent model, $\mu_0(\omega_l) = p_s$ as in section 2.

The following proposition summarizes the equilibrium in the entire signaling game.

Proposition 11. *1. When $\mu_0(\omega_l) > \frac{1}{\gamma+1}$,*

$$\beta = 0, \quad \alpha = \frac{1+\gamma}{d/c_v + \gamma};$$

2. When $\mu_0(\omega_l) < \frac{1}{\gamma+1}$, D always wins, and $\alpha = \beta = 0$.

Proposition 12. *The equilibrium in the two-agent model when the defendant persuades the judge during a trial has the following properties:*

(1) There is a pooling equilibrium where there is no litigation and V is not compensated when $p_s < \frac{1+\gamma c_v/d}{1+\gamma}$.

(2) *Litigation occurs if and only if* $p_s \geq \frac{1+\gamma c_v/d}{1+\gamma}$. *When this condition is satisfied, a non-liable D offers* $\sigma = 0$. *A liable D offers* $\sigma = 0$ *with probability* x, *and* $\sigma = \alpha d - c_v = \frac{1+\gamma}{d/c_v+\gamma} d - c_v$ *with probability* $1 - x$. *A settlement is successes when* $\sigma = d - c_v$; *and a trial occurs when* $\sigma = 0$ *with probability* r, *where*

$$x = \frac{1-p_s}{p_s} \frac{c_v/d - \beta}{\alpha - c_v/d} = \frac{1-p_s}{p_s} \frac{1/\gamma + c_v/d}{1 - c_v/d},$$
$$r = \frac{1 - c_v/\alpha d}{1 + c_v/\alpha d} = \frac{\gamma(1 - c_v/d)}{1 + \gamma + c_d/c_v + \gamma c_d/d}.$$

(3) *J's degree of sympathy towards V affects the signaling equilibrium: a higher* γ *(when J is more sympathetic to V) works in V's favor;*

(4) *V's winning rate at trial is* c_v/d.

Such results are obtained in the signaling equilibrium, as in Appendix F.

Comparing the two-agent signaling equilibrium in section 2 and this extension, we see that ceteris paribus, if $c_v < d$, the pooling equilibrium where V is never compensated is more likely when D can persuade J during a trial.

We applying the result of this extension to the numerical example in subsection 3.6.1. Suppose that J adopts a "more likely than not" standard, i.e., V wins if D is 50% liable. Because $\frac{1+\gamma c_v/d}{1+\gamma} = 0.68 > p_s = 0.163$, there is a pooling equilibrium with no litigation and no compensation for V.

In the separating equilibrium, the positive settlement amount offered by D is not dependent on V's belief, p_s, but is dependent on J's degree of sympathy towards V and V's trial winning rate. In general, V is better off when J is more sympathetic towards her, i.e., when γ is large. Specifically, as γ increases:

(1) A separating equilibrium is more likely because the threshold $\frac{1+\gamma c_v/d}{1+\gamma}$ decreases.

(2) The trail rate $(1 - p_s + p_s x)r$ increases.

(3) The threshold $\mu_s^*(\omega_l) = \frac{1}{1+\gamma}$ for V to win decreases, and V's trial winning rate in liable cases α increases.

(4) D is more likely to offer σ^* because x decreases, and the settlement amount σ^* increases. V is thus more likely to accept the settlement;

However, no matter whether a trial reveals the true state, V's trial winning rate is the same, and is equal to the ratio of V's court costs and the damages amount; this because the effect of the litigation process on D's and V's randomization strategies x and r each other cancel out.

5.3.3 Three-Agent Model Bayesian Persuasion in Litigation Reveals the True State

When L is in the game, there are two senders, L and D, who affect J's decision during a trial. Suppose that during a trial, L and D both use optimal signals, as in proposition 2, to persuade J. In such a setting, a trial reveals the truth for any decision rule p^* and any prior belief of J. Therefore, at trial, $\alpha = 1$ and $\beta = 0$.

Proposition 13. *If perfectly informed L and D both use the signaling structure in proposition 2 to persuade J in during trial, the trial will reveal the true state.*

The proof of proposition 13 is in Appendix G. Gentzkow & Kamenica, 2017 also suggests a similar result in their Bayesian persuasion framework. They then go on to provide a framework of Bayesian persuasion by multiple senders where the senders also strategically interact with one another. Such a framework provides richer information equilibria. In this extension here, the strategic interaction between L and D is not considered.

6 Conclusion

This article examined the effect of "ambulance chasing" by lawyers. In the main model, a profit-driven lawyer controls an imperfectly informed victim's information to affect the victim's litigation decision in a signaling game with a perfectly informed defendant. The comparison of the signaling games with and without lawyers shows that although victims' lawyers may increase the number of victims who obtain compensation, they also induce more litigation in the state where the defendants are not liable. In addition, lawyer's fees reduce the net awards to victims who receive compensation, and constitute a net cost to victims who file cases against non-liable defendants. Furthermore, although lawyers may identify more liable cases, their fees discourage litigation. For a range of realistic parameters, a lawyer may help encourage more safety costs from a potential injurer when the victim on her own is likely to mistake a liable case for a non-liable case.

The models presented in this article can be applied to broader contexts. In particular, the three-agent model in section 3 is a combination of the lawyer's persuasion found in proposition 2 and a standard two-agent signaling game found in section 2. Such an approach is novel and provides insights on the effect of expert advice. Specifically, in this particular model, the lawyer affects the signaling equilibrium between the victim and the defendant. Although the setup of the game is a tort case where an imperfectly informed victim interacts with a perfectly informed defendant in a signaling game, such a setting can easily be adapted to other civil cases, for example, contract or divorce cases, or even more generally, to situations in which an adviser solicits business from an imperfectly informed client who interacts with a perfectly informed opponent. For example, one could use the three-agent framework discussed here to analyze the effect of a financial adviser on a client who is about to begin an investment negotiation.

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A Baseline Model – Two-Agent Signaling Game

A.1 Settlement and Trial Choices

- Players: {Defendant (D), Victim (V), Nature(N)}
- Histories:

(1) N decides the state to be ω_l or ω_{nl}. D observes the state realization.

(2) V receives a signal $z = \{0, 1\}$ regarding the state.

(3) V files a claim against D if $z = 1$; thus in cases filed $P(\omega_l) = p_s$ in equation (2).

(4) D offers a settlement of σ to V.

(5) V decides whether to accept or to reject σ.

  - If V accepts, D transfers σ to V.
  - If V rejects, a court trial occurs. D loses and transfers amount d to V if and only if liable.
  - In a trial, the two parties also incur court costs c_v and c_d, for V and D, respectively.

A.2 Pooling Equilibrium

A.2.1 $\sigma = 0$ when $pd \leq c_v$

V always accepts $\sigma = 0$ in equilibrium because

$$p(d - c_v) + (1 - p)(-c_v) = pd - c_v \leq 0.$$

In such a case, D's and V's equilibrium payoffs are both 0.

A.2.2 $\sigma^* = pd - c_v$ when $\frac{c_v}{d} < p < \frac{c_v + c_d}{d} < 1$

- V accepts σ^* in equilibrium. V's equilibrium payoff is

$$\pi_V = pd - c_v.$$

  V has no incentive to deviate because the settlement amount is the same as the expected payoff from litigation.

- V would go to court for a trial if D deviates and offers V 0:

$$p(d - c_v) + (1 - p)(-c_v) > 0.$$

- However, D's payoff is lower from a trial than that from a settlement. For a non-liable D:

$$pd - c_v < c_d$$

  For a liable D, the expected payout from a trial would be $c_d + d > c_d > pd - c_v$.

- Therefore, D would not deviate.

A.2.3 No pooling equilibrium when $pd \geq c_v + c_d$

- When $pd \geq c_v + c_d$,

$$c_d < p(d - c_v) + (1 - p)(-c_v) < d + c_d.$$

- V will only accept offers $\sigma \geq p(d - c_v) + (1 - p)(c_v)$; however, D in $\Omega = \omega_{nl}$ would prefer to offer 0 and pay c_d in a trial rather than offering σ.

- D in $\Omega = \omega_l$ would prefer to offer σ rather than to offer 0 and incur costs $d + c_d$ from a trial.

A.3 Equilibria Selection: The Pooling Equilibrium $\sigma^* = pd - c_v$ When $\frac{c_v}{d} < p < \frac{c_v + c_d}{d}$ Do Not Survive the D1 Criterion

- D1 criterion: According to Cho and Kreps (1987), when there is a type t' tho wishes to defect and send message 0 whenever type t wishes to do so, then (t, m) is pruned from the game. Formally,

$$D_t = \left\{ \phi \in MBR(T(m), m) : u^*(t) < \sum_r u(t, m, r)\phi(r) \right\},$$
$$D_t^0 = \left\{ \phi \in MBR(T(m), m) : u^*(t) = \sum_r u(t, m, r)\phi(r). \right\}$$

- That is, if for some type t there exists a second type t' with $D_t \cup D_t^0 \subseteq D_{t'}$, then (t, m) may be pruned from the game.

- u^* is the expected payoff in equilibrium; ϕ is the receiver's mixed best response to m; and $\sum_r u(t, m, r)\phi(r)$ is the sender's expected deviation payoff given the best response.

- Here, consider a liable and a non-liable D. They can both offer 0 as a settlement. Because $-c_v < 0$ and $d - c_v > 0$, V plays the mixed strategy of accepting or rejecting when the type is unknown. Let $\phi = (1 - y, y)$ represent the probability of (accept, reject)

- For a non-liable D, $-pd + c_v < (1 - y) * 0 - yc_d \implies y \leq \frac{pd - c_v}{c_d}$.

- Therefore, $D_{nl} = [0, \frac{pd - c_v}{c_d})$; $D_{nl}^0 = [0, \frac{pd - c_v}{c_d}]$.

- Similarly, for a liable D, $D_l = [0, \frac{pd - c_v}{d + c_d})$; $D_l^0 = [0, \frac{pd - c_v}{d + c_d}]$.

- $D_l \cup D_l^0 \subseteq D_{nl}$. Therefore, a liable D is pruned for sending a settlement of 0. In other words, $(t, m) = (liable, 0)$ is ruled out.

- Thus, whenever V sees a settlement of 0, V believes that this is from a non-liable D, and will accept it. Therefore, a non-liable D will defect, and the pooling equilibrium will be eliminated.

A.4 Separating Equilibrium with Randomization When $c_v < d$ and $p \geq \frac{c_v}{d}$

- D offers 0 in ω_{nl} with probability 1. In ω_l, D offers 0 with probability x, and offers $\sigma^* = d - c_v$ with probability $1 - x$.

- Offer $\sigma \geq \sigma^*$ is accepted; any offer of $\sigma < \sigma^*$ is rejected with probability r.

- When offered 0, V is indifferent regarding the choice between accepting and rejecting:

$$(\frac{xp}{xp + (1-p)})(d - c_v) + (1 - \frac{xp}{xp + (1-p)})(-c_v) = 0$$
$$\frac{xp}{xp + (1-p)} = \frac{c_v}{d}$$
$$\implies x = \frac{1-p}{p} \frac{c_v/d}{1 - c_v/d}.$$

  Liable D is indifferent regarding the choice between offering σ^* and offering 0:

$$\begin{aligned} -(d - c_v) &= r(-d - c_d) + (1-r)0 \\ \implies \quad r &= \frac{1 - c_v/d}{1 + c_d/d}. \end{aligned} \tag{18}$$

- Non-liable D prefers to offer 0 over σ^* because $d - c_v > rc_d$.

- V's posterior belief is as follows: $\mu_s(\omega_l|\sigma^*) = 1$, $\mu_s(\omega_1|0) = \frac{xp}{xp+(1-p)}$

- The expected payoff for V is the following:

$$\pi_V = p(1-x)(d - c_v) + (1 - p + xp)r(-c_v + \frac{xp}{xp + 1 - p}d).$$

- The expected payout for D is the following:

$$\pi_D = -p(1-x)(d-c_v) + r(1-p+px)(-c_d - \frac{xp}{xp+1-p}d).$$

- The trial rate among filed cases is the following: $(1-p+xp)r$.

- The restrictions on the parameters are the following:

$$0 \le x, r \implies 0 \le \frac{c_v}{d} \le 1,$$
$$x \le 1 \implies p \ge \frac{c_v}{d}.$$

A.5 Summary of Equilibrium in the Baseline Model

The equilibrium of the baseline model is as follows:

(1) The main case is obtained when $p_s > \frac{c_v}{d}$. In such a case, there is a *separating* equilibrium where,

(i) if non-liable, D offers zero settlement

(ii) if liable, D randomizes between two offers: zero with probability

$$x = \frac{1-p_s}{p_s}\frac{c_v}{d-c_v} = \frac{\beta_1}{1-\beta_0}\frac{1-p_0}{p_0}\frac{c_v}{d-c_v},$$

and positive settlement amount

$$\sigma^* = d - c_v$$

with probability $1-x$;

(iii) V accepts positive offers σ^*, and rejects the zero offers with probability

$$r = \frac{d-c_v}{d+c_d}.$$

(2) When $p_s \leq \frac{c_v}{d}$, there is a pooling equilibrium where D offers zero to all Vs, and all Vs accept it. This situation is equivalent to V not filing a court case.

A.6 Probabilities of Going to Trial and Winning at Trial

Under the separating equilibrium (when $p_s > \frac{c_v}{d}$), a trial occurs when V rejects D's zero offers. Therefore, the probability of a court trial among the cases filed is

$$\begin{aligned}(1-p_s+p_s x)r &= (1-p_s)\frac{1}{1+c_d/d} \\ &= \frac{\beta_1(1-p_0)}{\beta_1(1-p_0)+(1-\beta_0)p_0}\frac{1}{1+c_d/d}.\end{aligned}$$

V's probability of winning at trial is the proportion of ω_l cases among the cases that go to trial:

$$\frac{xp}{1-p+xp} = c_v/d.$$

Because a trial reveals the true state, such a winning rate is the true proportion of liable cases among the cases that go to trial.

B Three-Agent model When $z = 0$

- Players: { Defendant (D), Victim (V), Lawyer (L), Nature (N)}
- Histories:

  (1) N decides the state. The state is ω_l with probability p_0, and is ω_{nl} with probability $1-p_0$. D and L observe the realization of the state.

  (2) Stage 0: V receives a signal $z = \{0,1\}$ regarding the state. Both L and D observe z as well. L sends a signal $m = \{0,1\}$ to V when $z = 0$. As a result, V files not only $z = 1$ cases but also some $z = 0$ cases.

  (3) D offers settlement σ to V.

(4) V decides whether to accept or reject σ according to V's posterior belief. If V rejects σ, a trial occurs.

B.1 L' Persuasion Signal to V

Proof of Proposition 2

Proof for Proposition 2. For L to be credible we need to require that

$$\mu_s(\omega_l) = P(m=1)P(\omega_l \mid m=1) + P(m=0)P(\omega_l \mid m=0) = \mu_0$$

That is, V's posterior belief after receiving L's signal is the same as the true state (which is also the same as her prior belief).

For V to follow L's signal and file a case whenever $m = 1$, V's posterior belief after receiving $m = 1$ should be equal to or greater than μ_t, the threshold for filing a claim.

$$P(\omega_l \mid m=1) = \frac{P(\omega_l, m=1)}{P(m=1)} \geq \mu_t. \tag{19}$$

Therefore, under L's signaling strategy, the proportion of case filings is $P(m = 1)$. L's objective is to bring about as many case filings as possible. In other words,

$$\max P(m=1)$$

We denote L's signal as follows.

$$\begin{aligned} P(m=1 \mid \omega_l) &= x, \qquad P(m=0 \mid \omega_l) = 1-x, \\ P(m=1 \mid \omega_{nl}) &= y, \qquad P(m=0 \mid \omega_{nl}) = 1-y. \end{aligned} \tag{20}$$

Therefore,

$$P(m=1) = P(m=1 \mid \omega_l)P(\omega_l) + P(m=1 \mid \omega_{nl})P(\omega_{nl}) = x\mu_0 + y(1-\mu_0),$$

$$P(m=0) = P(m=0 \mid \omega_l)P(\omega_l) + P(m=0 \mid \omega_{nl})P(\omega_{nl}) = (1-x)\mu_0 + (1-y)(1-\mu_0),$$

$$P(\omega_l \mid m=1) = \frac{P(\omega_l, m=1)}{P(m=1)} = \frac{x\mu_0}{x\mu_0 + y(1-\mu_0)},$$
$$P(\omega_l \mid m=0) = \frac{P(\omega_l, m=0)}{P(m=0)} = \frac{(1-x)\mu_0}{(1-x)\mu_0 + (1-y)(1-\mu_0)},$$
$$\mu_s(\omega_l) = P(\omega_l = 1, m=1) + P(\omega_l, m=0) = x\mu_0 + (1-x)\mu_0 = \mu_0.$$

Thus, L must solve the following maximization problem:

$$\max_{x,y} \; x\mu_0 + y(1-\mu_0)$$
$$s.t. \frac{x\mu_0}{x\mu_0 + y(1-\mu_0)} \geq \mu_t$$

Notice that as x increase, the left hand side increases. Therefore, we can set $x = 1$. As y increases, the left hand side decreases. Therefore, the constraint is binding; that is,

$$\frac{x\mu_0}{x\mu_0 + y(1-\mu_0)} = \mu_t, \;\; x = 1 \implies y = \frac{\mu_0}{1-\mu_0}\frac{1-\mu_t}{\mu_t}.$$
$$\implies P(m=1) = \frac{\mu_0}{\mu_t}$$

Plug x, y back into (7), we obtain L's optimal signal, which is of the form in (5). The total number of claims filed is $P(m=1) = \frac{\mu_0}{\mu_t} > \mu_0$ if $\mu_0 < \mu_t$. □

Proof of Proposition 3 V's signal z is distributed as follows:

$$P(z=1) = (1-\beta_0)p_0 + \beta_1(1-p_0),$$

$$P(z=0) = \beta_0 p_0 + (1-p_0)(1-\beta_1).$$

Among $z = 0$ cases, the probability that D is liable (ω_l) is

$$p_s' = P(\omega_l | z=0) = \frac{\beta_0 p_0}{\beta_0 p_0 + (1-p_0)(1-\beta_1)} < p_s.$$

Proof of Proposition 3. L's signaling strategy: As determined in equation (3), when $z = 0$, V's prior probability that D is liable (ω_l) is

$$p'_s = P(\omega_l | z = 0) = \frac{\beta_0 p_0}{\beta_0 p_0 + (1 - p_0)(1 - \beta_1)} < p_s$$

L's optimal signal is described in Proposition 2. In equilibrium, L solicits all liable cases and some non-liable cases until V's payoff from accepting the solicitation is the same as the payoff from rejecting the solicitation, which is 0. Modifying (5) in proposition 2 by replacing $\mu_0 = p'_s$ and $\mu_t = \frac{c_v + f + f_0}{\xi d}$, the lawyer's optimal signal in this game is as follows.

$$P(m = 1 | \omega_l) = 1,$$
$$P(m = 0 | \omega_l) = 0,$$
$$P(m = 1 | \omega_{nl}) = \frac{p'_s}{1 - p'_s} \frac{\xi d - c_v - f - f_0}{c_v + f + f_0} = \frac{\beta_0}{1 - \beta_1} \frac{p_0}{1 - p_0} \frac{\xi d - c_v - f - f_0}{c_v + f + f_0},$$
$$P(m = 0 | \omega_{nl}) = 1 - P(m = 1 | \omega_{nl}).$$

As a result, V's posterior belief after receiving L's signal is as follows.

$$\mu'_s(\omega_l | m = 1, z = 0) = \frac{c_v + f + f_0}{\xi d} > \frac{c_v}{d},$$
$$\mu'_s(\omega_l | m = 0, z = 0) = 0.$$

□

L sends signal $m = \{0, 1\}$ to V if $z = 0$. Let L's strategy in $z = 0$ be

$$P(m = 1 | \omega_l) = 1,$$
$$P(m = 0 | \omega_l) = 0,$$
$$P(m = 1 | \omega_{nl}) = k,$$
$$P(m = 0 | \omega_{nl}) = 1 - k.$$

This is the optimal signal in proposition 2. Therefore,

$$\mu_s'(\omega_l|m=1) = \frac{p_s'}{p_s' + k(1-p_s')},$$
$$\mu_s'(\omega_l|m=0) = 0.$$

V files cases when $m = 1$. Denote the probability of D being liable in $z = 0$ cases filed as $\bar{p}$. Therefore,

$$\bar{p} = \mu_s'(\omega_l|m=1) = \frac{p_s'}{p_s' + k(1-p_s')}.$$

The amount cases filed is:

$$P(z=0) * (p_s' + k(1-p_s'))$$

Such signal a is credible because

$$p_s' = \mu_s'(\omega_l|m=0)p(m=0) + \mu_s'(\omega_l|m=1)p(m=1) \quad = 0 + \bar{p} * (p_s' + k(1-p_s')) = p_s'.$$

B.2 Pooling Equilibrium in the Three-Agent model when $\xi d > c_v + f + f_0$

Suppose $\xi d \leq c_v + f + f_0$. In such a case, by accepting, V's payoff is less than 0. Thus, V does not take L's advice and does not file a case. Therefore, for a pooling equilibrium to exist, $\xi d \geq c_v + f + f_0$.

B.2.1 Case 1: $\sigma^* = f_0$ when $\xi d > c_v + f + f_0$ and $f_0 < c_d$

Suppose there is a pooling equilibrium where D offers $\xi d\bar{p} - c_v - f$ to all, and V accepts this offer. For V to accept L's advice and file a case, V's payoff from filing her case must be equal to or greater than not filing her case:

$$\xi d\bar{p} - c_v - f - f_0 \geq 0 \implies \xi d\bar{p} \geq c_v + f + f_0.$$

V's belief upon seeing the offer is still $\bar{p}$, and thus V has no incentive to deviate. To sustain such an equilibrium, a non-liable D must be willing to offer a settlement rather than go to a court trial. This requires

$$\xi d\bar{p} - c_v - f \leq c_d \implies \xi d\bar{p} \leq c_d + c_v + f.$$

Therefore, when $c_v + f + f_0 \leq \xi d\bar{p} \leq c_d + c_v + f$, there is a pooling equilibrium where D offers $\xi d\bar{p} - c_v - f$ to all, and V accepts this offer. This equilibrium requires $f_0 < c_d$.

L is paid f_0 when V files a case. L's payoff is

$$\pi_L = f_0(P(z = 0) * (p'_s + k(1 - p'_s))).$$

The only parameter that L controls in this equation is k. Thus, L wants to increase k. In other words, L wants to have the lowest $\bar{p} = \frac{p'_s}{p'_s + k(1-p'_s)}$. Therefore, $\bar{p} = \frac{c_f + f + f_0}{\xi d}$. Note that $\xi d\bar{p} > c_f + f + f_0$ is always satisfied. Thus,

$$\begin{aligned} \bar{p} &= \frac{p'_s}{p'_s + k(1 - p'_s)} = \frac{c_v + f + f_0}{\xi d} \\ \implies k &= \frac{p'_s}{1 - p'_s} \frac{\xi d - c_v - f - f_0}{c_v + f + f_0}. \end{aligned} \tag{21}$$

In equilibrium, when $\xi d > c_v + f + f_0$ and $f_0 < c_d$, D offers f_0 to V, and V accepts.

B.2.2 Case 2: No Pooling Equilibrium When $\xi d > c_v + f + f_0$ and $f_0 > c_d$

Suppose $\xi d\bar{p} > c_d + c_v + f$. This implies that $f_0 > c_d$. In such a case, a non-liable D would prefer a court trial over offering the settlement amount of $\xi d\bar{p} - c_v - f$. Thus, there is no pooling equilibrium.

B.3 Equilibrium Selection: Pooling Equilibrium When $f_0 < c_d$ Can Be Eliminated by the D1 Criterion

We apply the D1 criterion the same way as in Appendix A.4.

- Consider the situation where both liable and non-liable Ds offer 0 as a settlement. Because $-c_v - f < 0$ and $\xi d - c_v - f > 0$, V plays a mixed strategy. Let $\phi = (1-y, y)$ be the probability of (accept, reject).
- For a non-liable D, $-f_0 < (1-y) * 0 - y * (c_d) \implies y < \frac{f_0}{c_d}$.
- For a liable D, $-f_0 < (1-y) * 0 - y * (c_d + d) \implies y < \frac{f_0}{c_D}$.
- Therefore, $D_{nl} = \left[0, \frac{f_0}{c_d}\right)$, $D_{nl}^0 = \left[0, \frac{f_0}{c_d}\right]$; $D_l = \left[0, \frac{f_0}{c_d+d}\right)$, $D_l^0 = \left[0, \frac{f_0}{c_d+d}\right]$.
- Because $D_l \cup D_l^0 \subseteq D_{nl}$, a liable D is pruned from sending a settlement of zero by the D1 criterion.
- Therefore, whenever V sees a settlement of zero, V believes it is from a non-liable, and will accept it because $-c_v - f < 0$. As a result, a non-liable D will defect and the pooling equilibrium will be eliminated.

B.4 Separating Equilibrium with Randomization When $\xi d \geq c_v + f + f_0$.

D's offer is:

$$\sigma^* = \begin{cases} \xi d - c_v - f & \text{by liable D with probability 1-x} \\ 0 & \text{by non-liable D w.p. 1, by liable D w.p. x.} \end{cases}$$

V's action is:

$$\sigma^* = \begin{cases} \xi d - c_v - f & \text{accepted by V,} \\ 0 & \text{rejected by V with probability r.} \end{cases}$$

In the settlement game, for V to randomize, V must be indifferent regarding the choice between rejecting and accepting 0:

$$\frac{x\bar{p}}{x\bar{p}+1-\bar{p}}(\xi d - c_v - f) + \frac{1-\bar{p}}{x\bar{p}+1-\bar{p}}(-c_v - f) - f_0 = -f_0,$$
$$\implies x = \frac{1-\bar{p}}{\bar{p}} \frac{c_v + f}{\xi d - c_v - f}.$$

For a liable D to randomize, the liable D must be indifferent regarding the choice between a settlement and a trial:

$$\xi d - c_v - f = 0 + r(d + c_d) \implies r = \frac{\xi d - c_v - f}{d + c_d}$$

For V to be willing to file a case in the first place, $\pi_V \geq 0$, this puts a restriction on $\bar{p}$:

$$\begin{aligned}\pi_V &= (\xi d - c_v - f - f_0)\bar{p}(1-x) + (-f_0)(1 - \bar{p} + x\bar{p}) \\ &= (\xi d - c_v - f)\bar{p}(1-x) - f_0 \geq 0 \\ &\implies \bar{p} \geq \frac{f_0}{(\xi d - c_v - f)(1-x)}.\end{aligned}$$

We then plug in x,

$$\begin{aligned}\bar{p} &\geq \frac{\bar{p} f_0}{\xi d \bar{p} - c_v - f} \\ &\implies \bar{p}(\xi d \bar{p} - c_v - f - f_0) \geq 0 \\ &\implies \bar{p} \geq \frac{c_v + f + f_0}{\xi d}.\end{aligned}$$

L's payoff in such a game would be:

$$\begin{aligned}\pi_L &= P(z=0)(p_s' + k(1-p_s'))(f_0 + (1 - \bar{p} + x\bar{p})r(f + \frac{x\bar{p}}{1-\bar{p}+x\bar{p}}(1-\xi)d)) \\ &= P(z=0)\left(p_s' f_0 + (1-p_s')\left(f_0 + \frac{\xi d}{d+c_d}\left(f + \frac{1-\xi}{\xi}(c_v+f)\right)\right)k\right).\end{aligned} \tag{22}$$

Because π_L increases with k, L wants to increase k, which is the equivalent of decreasing

$\bar{p}$ from equation (8). Therefore,

$$\begin{aligned}\bar{p} = \frac{c_v + f + f_0}{\xi d} &= \frac{p'_s}{p'_s + k(1-p'_s)} \\ \implies k = \frac{p'_s}{1-p'_s}&\frac{\xi d - c_v - f - f_0}{c_v + f + f_0}.\end{aligned} \tag{23}$$

We then plug in k to obtain x:

$$\begin{aligned}x =& \frac{1-\bar{p}}{\bar{p}} \frac{c_v + f}{\xi d - c_v - f} \\ =& \frac{\xi d - c_v - f - f_0}{\xi d - c_v - f} \frac{c_v + f}{c_v + f + f_0}.\end{aligned}$$

Thus, the probability of a trial among the cases filed because of L's solicitation is:

$$\begin{aligned}&P(z=0)(p'_s + k(1-p'_s))(1-\bar{p} + x\bar{p})r \\ &= P(z=0)p'_s \frac{\xi d}{d + c_d} \frac{\xi d - c_v - f - f_0}{c_v + f + f_0}.\end{aligned}$$

The probability of winning at trial is:

$$\frac{x\bar{p}}{1-\bar{p}+x\bar{p}} = \frac{c_v + f}{\xi d}.$$

B.5 Summary of Equilibrium in Three-Agent Model When Z=0

In equilibrium, V's belief that D liable is $\bar{p} = \frac{c_v+f+f_0}{\xi d}$ in $z = 1$ cases. V hires L only when $\xi d - c_v - f - f_0 > 0$. There, there is a separating equilibrium with randomization. L's signal is as follows:

$$k = \frac{p'_s}{1-p'_s} \frac{\xi d - c_v - f - f_0}{c_v + f + f_0} = \frac{\beta_0}{1-\beta_1} \frac{p_0}{1-p_0} \frac{\xi d - c_v - f - f_0}{c_v + f + f_0}.$$

D's offer is as follows:

$$\sigma^* = \begin{cases} \xi d - c_v - f & \text{by liable D with probability 1-x,} \\ 0 & \text{by non-liable D w.p. 1, by non liable D w.p. x.} \end{cases}$$

V's strategy is as follows:

$$\sigma^* = \begin{cases} \xi d - c_v - f & \text{accepted by V,} \\ 0 & \text{rejected by V with probability r.} \end{cases}$$

where

$$x = \frac{\xi d - c_v - f - f_0}{\xi d - c_v - f} \frac{c_v + f}{c_v + f + f_0}, \quad r = \frac{\xi d - c_v - f}{d + c_d}.$$

B.6 Proof of Propositions 6 and 7

Proof of Proposition 6

Proof of Proposition 6.

1. When $z = 0$, V hires L only when $\xi d \geq c_v + f + f_0$. When $z = 1$, V hires L only when $\xi d p_s \geq c_v + f + f_0$. Ceteris paribus, such conditions are more likely to be satisfied when $f, f_0, 1 - \xi$ are low and when d is high.

2. When V is more likely to make a type II error, namely, when β_0 is higher, $P(z = 0) = \beta_0 p_0 + (1 - p_0)(1 - \beta_1)$ and p'_s are both higher. L corrects such a type II error when $z = 0$, and increases the total number of cases by $P(z = 0)p'_s \frac{\xi d}{c_v+f+f_0}$. Thus, a higher β_0 would mean that the lawyer's solicitation is more likely to be successful. When $z = 1$, V hires L when $\xi d p_s \geq c_v + f + f_0$, and thus, is more likely to hire L when p_s is high, namely, when V's signal is more precise.

□

Proof of Proposition 7

Proof of Proposition 7. 1. The increase in the number of cases filed follows from equation (8). No pooling equilibrium follows from the equilibrium characterizations found in propositions 4 and 5.

2. This conclusion follows from equilibrium trial wining rates proposition 1(3) and equations (10) and (12).

3. This conclusion follows from equilibrium characterizations in proposition 4 and 5.

□

C Three Agent Model When $z = 1$ and $\xi dp_s \geq c_v + f + f_0$

When $z = 1$, L does not affect V's belief. Rather, L increases the trial winning rate in cases where D is liable. Suppose $\xi dp_s \leq c_v + f + f_0$. With such parameters, V's expected payoff for filing a case is less than 0. Therefore, V would not hire a lawyer, and this situation would reduce to the two-agent signaling game. V only hires L when $\xi dp_s \geq c_v + f + f_0$.

C.1 Pooling Equilibrium When $\xi dp_s \leq c_v + f + c_d$

Suppose there is a pooling equilibrium where D offers $\xi dp_s - c_v - f$ to all, and V accepts this offer. To sustain such an equilibrium, a non-liable D must prefer to settle rather than go to trial. f_0 is considered a sunk cost, and thus, does not affect the offer. Thus,

$$\xi dp_s - c_v - f \leq c_d.$$

Therefore, when $c_v + f + f_0 \leq \xi dp_s \leq c_v + f + c_d$ there is a pooling equilibrium where D offers $\xi dp_s - c_v - f$ to all, and V accepts.

When $\xi dp_s > c_v + f + f_0 + c_d$, a non-liable D would not offer such a settlement and would prefer to go to trial. hence, there is no pooling equilibrium.

C.2 Equilibrium Selection: D1 Criterion Prunes Pooling Equilibrium

The pooling equilibrium when $c_v + f + f_0 \leq \xi d p_s \leq c_v + f + f_0 + c_d$ can be pruned by the D1 criterion as in Appendices A.4 and B.3. D1 criterion states that when there is type t' wishes to defect and send message m whenever type t wishes to do so, then (t, m) is pruned from the game. In our case, whenever liable D wants to send 0, then non-liable D wants to send 0. Thus (liable, 0) is ruled out. Therefore, non-liable D would only offer 0. The pooling equilibrium does not survive the D1 criterion.

C.3 Separating Equilibrium with Randomization

In a separating equilibrium with randomization, D and V's strategies are as follows.

D's offer is:

$$\sigma^* = \begin{cases} \xi d - c_v - f & \text{by liable D with probability 1-x,} \\ 0 & \text{by non-liable D w.p. 1, by non liable D w.p. x.} \end{cases}$$

V's action is:

$$\sigma^* = \begin{cases} \xi d - c_v - f & \text{accepted by V,} \\ 0 & \text{rejected by V with probability r.} \end{cases}$$

V's must be indifferent regarding the choice between rejecting and accepting 0:

$$\begin{aligned} &\frac{x p_s}{x p_s + 1 - p_s}(\xi d - c_v - f) + \frac{1 - p_s}{x p_s + 1 - p_s}(-c_v - f) - f_0 = -f_0 \\ &\implies x = \frac{1 - p_s}{p_s} \frac{c_v + f}{\xi d - c_v - f}. \end{aligned}$$

For a liable D to randomize, the payoff from a settlement and from a trial would need to be the same:

$$\xi d - c_v - f = 0 + r(d + c_d)$$
$$\implies r = \frac{\xi d - c_v - f}{d + c_d}.$$

For V to be willing to file a case, $\pi_V \geq 0$:

$$\pi_V = (\xi d - c_v - f - f_0)p_s(1 - x) + (-f_0)(1 - p_s + xp_s)$$
$$= (\xi d - c_v - f)p_s(1 - x) - f_0 \geq 0$$
$$\implies p_s \geq \frac{f_0}{(\xi d - c_v - f)(1 - x)}.$$

We then plug in x to restrict the parameters,

$$p_s \geq \frac{p_s f_0}{\xi d p_s - c_v - f}$$
$$\implies p_s(\xi d p_s - c_v - f - f_0) \geq 0$$
$$\implies \xi d p_s \geq c_v + f + f_0.$$

Such a condition is always satisfied in the assumption of this subsection.

The probability of a trial is

$$(1 - p_s + xp_s)r = (1 - p_s)\frac{\xi d}{d + c_d}.$$

The probability of winning at trial is:

$$\frac{xp_s}{1 - p_s + xp_s} = \frac{c_v + f}{\xi d}.$$

C.4 Summary of the Three-Agent Settlement Game When z=1

- V only hires L when $\xi d p_s \geq c_v + f + f_0$.

- There only exists a separating equilibrium:

$$\sigma^* = \begin{cases} \xi d - c_v - f & \text{by liable D with probability 1-x,} \\ 0 & \text{by non-liable D w.p. 1, by non liable D w.p. x.} \end{cases}$$

V's action is the following:

$$\sigma^* = \begin{cases} \xi d - c_v - f & \text{accepted by V,} \\ 0 & \text{rejected by V with probability r,} \end{cases}$$

where

$$x = \frac{1-p_s}{p_s}\frac{c_v+f}{\xi d - c_v - f} = \frac{1-p_0}{p_0}\frac{1-\beta_1}{\beta_0}\frac{c_v+f}{\xi d - c_v - f}$$
$$r = \frac{\xi d - c_v - f}{d + c_d}.$$

Notice that in V's and D's strategy spaces, V's randomization strategy, r, and the trial winning rate are the same as those in the scenario of the lawyer's solicitation when $z = 0$ in Appendix B; while the trial probabilities and D's randomization strategies, x, in the two situations are different.

C.5 Calculation for numerical example in subsection 3.6.1

Without lawyers, V gets $z = 1$ in $100*0.7+900*0.1 = 160$ injuries. V files claims against D in all 160 cases for which she thinks D is liable. Thus, $p_s = \frac{0.1*0.7}{0.7*0.1+0.1*0.9} = 0.4375$ by (2). According to propositions 1(2), because $p_s = 0.4375 > \frac{c_v}{d} = 0.05$, there is a separating equilibrium where V files 160 cases against D. By Proposition 1(2), the randomization of V and D are $x = \frac{1-0.4375}{0.4375}\frac{50}{950} \approx 0.068$, and $r = \frac{950}{1100} \approx 0.86$. Therefore, V obtains a settlement of \$950 in $70(1-x) \approx 65$ liable cases. There are $r(160-65) \approx 82$ trials, and V only win around $70-65 = 5$ of them. Thus, the trial winning rate is around 6%.

When V is represented by L, in the 160 injuries for which V gets $z = 1$, there are 70 liable cases. By Proposition 5(b), $x = \frac{1-0.4375}{0.4375}\frac{50+100}{700-50-100} \approx 0.35$, and $r = \frac{700-50-100}{1000+100} \approx 0.5$. Therefore, with the help of L, V gets a settlement of \$550 (\$700 − \$50 − \$100 = \$550) from D in $70(1-x) \approx 45$ of the 70 liable cases. Court trials occur in around $r*(160-45) \approx 57$ cases, among which, about $57 * \frac{70-45}{160-45} \approx 12$ are liable. Thus, V's trial winning rate is $\frac{12}{57} \approx 21$ %.

In the 840 injuries for which V gets $z = 0$, D is liable in $100 * 0.3 = 30$ of them. By (7), L can persuade V to file around $0.3 * 0.1 * \frac{700}{50+100+20} * 1000 \approx 124$ claims against D – among them, there are all the 30 liable cases and around 94 non-liable cases. In equilibrium, $x = \frac{700-50-100-20}{700-50-100} \times \frac{50+100}{50+100+20} \approx 0.85$, and $r = \frac{700-50-100}{1000+100} \approx 0.5$. Thus, D offers a settlement of $\$(700 - 50 - 100) = 550$ to V in about $30 * (1-x) \approx 5$ liable cases, and offers \$0 in all the remaining cases. In the end, $(124 - 5) * r \approx 60$ cases go to trial, and V wins $60 * \frac{30-5}{124-5} \approx 13$ of them, resulting in a winning probability rate of 21%.

D Extension 1: When L is Imperfectly Informed

L gets a noisy signal, s:

$$P(s = 1|\omega_l) = 1 - \theta_0,$$

$$P(s = 0|\omega_l) = \theta_0 \text{ (a false negative, or type II error)},$$

$$P(s = 1|\omega_{nl}) = \theta_1 \text{ (a false positive, or a type I error)},$$

$$P(s = 0|\omega_{nl}) = 1 - \theta_1.$$

Therefore, L's posterior belief after this signal is:

$$\mu_d = P(\omega_l \mid s = 1) = \frac{p_0(1-\theta_0)}{p_0(1-\theta_0) + (1-p_0)\theta_1},$$
$$\mu_d' = P(\omega_l \mid s = 0) = \frac{p_0\theta_0}{p_0\theta + (1-p_0)(1-\theta_1)}.$$

D.1 L's Persuasion Signaling Strategy

L's signaling strategy would be as follows:

$$P(m = 1|s = 1) = 1$$

$$P(m = 0|s = 1) = 0$$

$$P(m = 1|s = 0) = k$$

$$P(m = 0|s = 0) = 1 - k$$

In other words, L's strategy $m = \{0, 1\}$ only depends on s:

$$P(\omega, m \mid s) = P(\omega \mid s)P(m \mid s)$$

Therefore, the state ω and L's signal m to b are *mutually independent, conditional on the signal* s. Intuitively, L distinguishes state ω_l from state ω_{nl} only as well as his signal, s. If L's signal is $s = 1$, he tells V that D is liable; and if L's signal is $s = 0$, with some probability k, he tells V that L is liable. L's signal has the following distribution:

$$\begin{aligned} P(s = 1) &= P(s = 1 \mid \omega_l)P(\omega_l) + P(y =\mid \omega_{nl})P(\omega_{nl}) \\ &= (1 - \theta_0)p_0 + \theta_1(1 - p_0), \\ P(s = 0) &= P(s = 0 \mid \omega_l)P(\omega_l) + P(y = 0 \mid \omega_{nl})P(\omega_{nl}) \quad = \theta_0 p_0 + (1 - p_0)(1 - \theta_1). \end{aligned}$$

Therefore, the signal m that V receives from L has the following probabilities:

$$\begin{aligned} P(m = 1) &= P(m = 1 \mid s = 1)P(s = 1) + P(m = 1 \mid s = 0)P(s = 0) \\ &= P(s = 1) + kP(s = 0) \\ &= (1 - \theta_0)p_0 + \theta_1(1 - p_0) + k[\theta_0 p_0 + (1 - p_0)(1 - \theta_1)], \\ P(m = 0) &= 1 - P(m = 1) \\ &= (1 - k)[1 - \theta_1 - p_0(1 - \theta_0 - \theta_1)]. \end{aligned}$$

Given L's signal quality, and the fact that m and ω are mutually independent conditional on s, we obtain the following joint probability distribution for the true state and L's signal to V, m, which is conditional on L's own signal s:

$$P(\omega_l, m = 1 \mid s = 1) = P(\omega_l \mid s = 1)P(m = 1 \mid s = 1) = \mu_d = \frac{p_0(1-\theta_0)}{p_0(1-\theta_0) + (1-p_0)\theta_1},$$
$$P(\omega_l, m = 0 \mid s = 1) = P(\omega_l \mid s = 1)P(m = 0 \mid s = 1) = 0,$$
$$P(\omega_{nl}, m = 1 \mid s = 1) = P(\omega_{nl} \mid s = 1)P(m = 1 \mid s = 1) = 1 - \mu_d = \frac{(1-p_0)\theta_1}{p_0(1-\theta_0) + (1-p_0)\theta_1},$$
$$P(\omega_{nl}, m = 0 \mid s = 1) = (\omega_{nl} \mid s = 1)P(m = 0 \mid s = 1) = 0,$$
$$P(\omega_l, m = 1 \mid s = 0) = (\omega_l \mid s = 0)P(m = 1 \mid s = 0) = k\mu_d' = \frac{kp_0\theta_0}{p_0\theta_0 + (1-p_0)(1-\theta_1)},$$
$$P(\omega_l, m = 0 \mid s = 0) = (\omega_l \mid s = 0)P(m = 0 \mid s = 0) = (1-k)\mu_d' = \frac{(1-k)p_0\theta_0}{p_0\theta_0 + (1-p_0)(1-\theta_1)},$$
$$P(\omega_{nl}, m = 1 \mid y = 0) = (\omega_{nl} \mid s = 0)P(m = 1 \mid s = 0) = k(1-\mu_d') = \frac{k(1-p_0)(1-\theta_1)}{p_0\theta_0 + (1-p_0)(1-\theta_1)},$$
$$P(\omega_{nl}, m = 0 \mid y = 0) = (\omega_{nl} \mid s = 0)P(m = 0 \mid s = 0) = (1-k)(1-\mu_d') = \frac{(1-k)(1-p_0)(1-\theta_1)}{p_0\theta_0 + (1-p_0)(1-\theta_1)}.$$

By Bayes rule, the conditional probabilities of the true state on L's own signal s and L's signal to V, s, are as follows:

$$P(\omega_l \mid m = 1, s = 1) = P(\omega_l, m = 1 \mid s = 1)/P(m = 1) = \frac{\mu_d}{P(m = 1)},$$
$$P(\omega_l \mid m = 0, s = 1) = P(\omega_l, m = 0 \mid s = 1)/P(m = 0) = 0,$$
$$P(\omega_{nl} \mid m = 1, s = 1) = P(\omega_{nl}, m = 1 \mid s = 1)/P(m = 1) = \frac{1-\mu_d}{P(m = 1)},$$
$$P(\omega_{nl} \mid m = 0, s = 1) = P(\omega_{nl}, m = 0 \mid s = 1)/P(m = 0) = 0,$$
$$P(\omega_l \mid m = 1, s = 0) = P(\omega_l, m = 1 \mid s = 0)/P(m = 1) = \frac{k\mu_d'}{P(m = 1)},$$
$$P(\omega_l \mid m = 0, s = 0) = P(\omega_l, m = 0 \mid s = 0)/P(m = 0) = \frac{(1-k)\mu_d'}{P(m = 0)},$$
$$P(\omega_{nl} \mid m = 1, s = 0) = P(\omega_{nl}, m = 1 \mid s = 0)/P(m = 1) = \frac{k(1-\mu_d')}{P(m = 1)},$$
$$P(\omega_{nl} \mid m = 0, s = 0) = P(\omega_{nl}, m = 0 \mid s = 0)/P(m = 0) = \frac{(1-k)(1-\mu_d')}{P(m = 0)}.$$

Therefore, a signal m from L conveys the following information:

$$\begin{aligned}
P(\omega_l \mid m=1) &= P(\omega_l \mid m=1, s=1)P(y=1) + P(\omega_l \mid m=1, s=0)P(s=0) \\
&= \frac{\mu_d}{P(m=1)}P(s=1) + \frac{k\mu_d'}{P(m=1)}P(s=0) \\
&= \frac{\mu_d P(y=1) + k\mu_d' P(y=0)}{P(s=1) + kP(y=0)} \\
&= \frac{p_0}{p_0(1-\theta_0) + (1-p_0)} \left[\frac{1-\theta_0}{1 + k\frac{\theta_0 p_0 + (1-p_0)(1-\theta_1)}{(1-\theta_0)p_0 + \theta_1(1-p_0)}} + \frac{\theta_0}{1 + \frac{1}{k}\frac{(1-\theta_0)p_0 + \theta_1(1-p_0)}{\theta_0 p_0 + (1-p_0)(1-\theta_1)}} \right],
\end{aligned}$$

$$\begin{aligned}
P(\omega_l \mid m=0) &= P(\omega_l \mid m=0, s=1)P(s=1) + P(\omega_l \mid m=0, s=0)P(s=0) \\
&= \frac{k\mu_d'}{P(m=0)}P(s=0) \\
&= \frac{k\mu_d'}{P(y=1) + kP(s=0)}P(s=0) \\
&= \frac{kp_0\theta_0}{p_0\theta_0 + (1-p_0)(1-\theta_1)} \frac{\theta_0 p_0 + (1-p_0)(1-\theta_1)}{(1-\theta_0)p_0 + \theta_1(1-p_0) + k[\theta_0 p_0 + (1-p_0)(1-\theta_1)]} \\
&= \frac{p_0}{p_0\theta_0 + (1-p_0)(1-\theta_1)} \frac{\theta_0}{1 + \frac{1}{k}\frac{(1-\theta_0)p_0 + \theta_1(1-p_0)}{\theta_0 p_0 + (1-p_0)(1-\theta_1)}},
\end{aligned}$$

$$P(\omega_{nl} \mid m=1) = 1 - P(\omega_l \mid m=1),$$

$$P(\omega_{nl} \mid m=0) = 1 - P(\omega_l \mid m=0).$$

Thus, we can see that $P(\omega_l \mid m=1)$ increases with k, whereas $P(\omega_l \mid m=0)$ increases with k only when $\theta_0 > 0.5$. (Denote $x = k\frac{\theta_0 p_0 + (1-p_0)(1-\theta_1)}{(1-\theta_0)p_0 + \theta_1(1-p_0)}$. Then $\frac{d}{dm}(\frac{1-\theta_0}{1+m} + \frac{\theta_0}{1+1/m}) = \frac{2\theta_0 - 1}{(m+1)^2}$.)

L's signal given his strategy and given the imperfect information, is the following:

$$
\begin{aligned}
P(m=1 \mid \omega_l) &= \frac{P(\omega_l \mid m=1)P(m=1)}{p_0} = \frac{\mu_d P(s=1) + k\mu_d' P(s=0)}{p_0} \\
&= \frac{(1-\theta_0)}{p_0(1-\theta_0)+(1-p_0)\theta_1}[(1-\theta_0)p_0 + \theta_1(1-p_0)] \\
&+ \frac{k\theta_0}{p_0\theta_0 + (1-p_0)(1-\theta_1)}[\theta_0 p_0 + (1-p_0)(1-\theta_1)] \\
&= 1-\theta_0 + k\theta_0, \\
P(m=1 \mid \omega_{nl}) &= \frac{P(\omega_{nl} \mid m=1)P(m=1)}{1-p_0} = \frac{P(m=1) - \mu_d P(s=1) - k\mu_d' P(s=0)}{1-p_0} \\
&= \frac{P(s=1) + kP(s=0) - \mu_d P(s=1) - k\mu_d' P(s=0)}{1-p_0} \\
&= \frac{P(s=1)(1-\mu_d) - kP(s=0)(1-\mu_d')}{1-p_0} \\
&= \frac{[(1-\theta_0)p_0 + \theta_1(1-p_0)]\left[\frac{(1-p_0)\theta_1}{p_0(1-\theta_0)+(1-p_0)\theta_1}\right]}{1-p_0} \\
&- \frac{[\theta_0 p_0 + (1-p_0)(1-\theta_1)]\left[\frac{k(1-p_0)(1-\theta_1)}{p_0\theta_0+(1-p_0)(1-\theta_1)}\right]}{1-p_0} \\
&= \theta_1 - k(1-\theta_1),
\end{aligned}
$$

$$
\begin{aligned}
P(m=0 \mid \omega_l) &= 1 - P(m=1 \mid \omega_l) = (1-k)\theta_0, \\
P(m=0 \mid \omega_{nl}) &= 1 - P(m=1 \mid \omega_{nl}) = (1+k)(1-\theta_1).
\end{aligned}
$$

From the above, we have now obtained L's persuasion signaling strategy as a function of his information. Next, we solve for k in the signaling game. The assumptions regarding the parameters in the models are as follows: $0 < \theta_1, \theta_0 < 0.5$, $k < \frac{\theta_1}{1-\theta_1} < 1$.

D.2 L's Solicitation When $z = 0$

Before receiving L's signal, V's prior belief that D is liable is p_s'.

$$
p_s' = P(\omega_l | z=0) = \frac{\beta_0 p_0}{\beta_0 p_0 + (1-p_0)(1-\beta_1)}.
$$

L can cause V's posterior belief to be the following:

$$\mu_v(\omega_l \mid m=1) = \frac{P(m=1 \mid \omega_l)p_s'}{P(m=1)} = \frac{(1-\theta_0+k\theta_0)p_s'}{(1-\theta_0)p_0+\theta_1(1-p_0)+k[\theta_0 p_0+(1-p_0)(1-\theta_1)]},$$
$$\mu_v(\omega_l \mid m=0) = \frac{P(m=0 \mid \omega_l)p_s'}{P(m=0)} = \frac{\theta_0 p_s'}{1-\theta_1-p_0(1-\theta_0-\theta_1)}.$$

We want to find out how μ_v changes with k. Thus, we take the following derivatives:

$$\frac{\partial \mu_v(\omega_l \mid m=1)}{\partial k} = \frac{(1-p_0)p_s'(\theta_0+\theta_1-1)}{(...)^2} < 0,$$
$$\frac{\partial \mu_v(\omega_l \mid m=0)}{\partial k} = 0.$$

If k increase (L sends more of $m=1$ when he receives $s=0$), V's posterior belief of D being liable after receiving $m=1$ decreases. However, V's posterior belief of D being liable after receiving $m=0$ is not affected by the change of k. Comparing this situation with the result found in Appendix B, we can see that k affects V's posterior belief in the same way.

V files a case when $m=1$. Thus, the number of cases filed is

$$P(m=1) = (1-\theta_0)p_0+\theta_1(1-p_0)+k[\theta_0 p_0+(1-p_0)(1-\theta_1)].$$

The probability that D is liable in the cases filed is the following:

$$\begin{aligned}\bar{p_v} = \mu_v(\omega_l \mid m=1) &= \frac{(1-\theta_0+k\theta_0)p_s'}{(1-\theta_0)p_0+\theta_1(1-p_0)+k[\theta_0 p_0+(1-p_0)(1-\theta_1)]} \\ &= \frac{(1-\theta_0+k\theta_0)}{(1-\theta_0)p_0+\theta_1(1-p_0)+k[\theta_0 p_0+(1-p_0)(1-\theta_1)]}\frac{\beta_0 p_0}{\beta_0 p_0+(1-p_0)(1-\beta_1)}\end{aligned}$$

To solve for k, we identify the equilibrium in the game.

D.2.1 Pooling Equilibrium when $\xi d > c_v + f + f_0$

V will only hire L when $\xi d > c_v + f + f_0$. This is because when $\xi d \leq c_v + f + f_0$, D will offer 0 in a settlement, and the highest possible amount V would get from a trial is

$\xi d - c_v - f - f_0 < 0$.

D.2.2 Separating Equilibrium with Randomization

When $\xi d > c_v + f + f_0$, there is a separating equilibrium in V's strategy:

$$\bar{p_v} = \frac{c_v + f + f_0}{\xi d}.$$

Therefore, V's and D's randomization strategies – x and r, respectively, – are the same as those found in section Appendix B. This also give the value of k as follows:

$$\begin{aligned} k &= \frac{\xi d(1-\theta_0)p'_s - (c_v + f + f_0)[(1-\theta_0)p_0 + \theta_1(1-p_0)]}{(c_v + f + f_0)[\theta_0 p_0 + (1-p_0)(1-\theta_1)] - \xi d\theta_0 p'_s}, \\ 1 - k &= \frac{c_v + f + f_0 - \xi d p'_s}{(c_v + f + f_0)[\theta_0 p_0 + (1-p_0)(1-\theta_1)] - \xi d\theta_0 p'_s}. \end{aligned}$$

The wining rate from a trial is the same as that found in section section 3:

$$\frac{x\bar{p_v}}{1 - \bar{p_v} + x\bar{p_v}} = \frac{c_v + f}{\xi d}.$$

The number of cases filed increases by the following:

$$\begin{aligned} P(m=1) * P(z=0) &= \{(1-\theta_0)p_0 + \theta_1(1-p_0) + k[\theta_0 p_0 + (1-p_0)(1-\theta_1)]\} * P(z=0) \\ &= \frac{\xi d p'_s(1-p_0)(1-\theta_0-\theta_1)}{[\theta_0 p_0 + (1-p_0)(1-\theta_1)](c_v + f + f_0) - \xi d\theta_0 p'_s} * P(z=0) \end{aligned}$$

When $\theta_1 = \theta_0 = 0$, the number of cases filed is $\frac{\xi d p'_s}{c_v + f + f_0}$, which is the case when L is fully informed. The probability of a trial increases by the following:

$$\begin{aligned} &P(z=0) * P(m=1) * (1 - \bar{p_v} + x\bar{p_v})r \\ &= P(z=0) * P(m=1) * \frac{\xi d - c_v - f - f_0}{d + c_d}. \end{aligned}$$

Thus, when L has imperfect information, the winning rate at trial is still $\frac{c_v+f}{\xi d}$. If L is more informed than V (L's signal s is less noisy), L can increase litigation. If L is almost perfectly informed, the equilibrium converges to the perfectly informed L situation discussed in section 3.

D.3 Equilibrium when $z = 1$ is not Affected

When L receives an imperfect signal, the equilibrium when $z = 1$ is not affected, as L does not need to solicit V. The assumption is that after V voluntarily hires L, L becomes fully informed during the discovery stage.

E Extension 2: L's Solicitation When Altruistic

Consider the situation where L internalizes V's utility:

$$U_L = (1-\delta)\pi_L + \delta\pi_V, \quad \delta \in [0,1].$$

As before, according to Proposition 2, L's persuasion signal to V is:

$$\begin{aligned}
&P(m=1|\omega_l) = 1,\\
&P(m=0|\omega_l) = 0,\\
&P(m=1|\omega_{nl}) = k,\\
&P(m=0|\omega_{nl} = 1-k, 0 \leq k \leq 1.
\end{aligned}$$

Under such a signaling strategy, and given that V's prior belief that D is liable is p_s', V's posterior belief is $\bar{p} = \frac{p_s'}{p_s'+k(1-p_s')}$.

We consider only the case where $\xi d \geq c_v + f + f_0$, and there is only a separating equilibrium:

1. If not liable, D offers zero settlement, and there is no litigation.

2. If liable, D randomizes between two offers: zero with probability

$$x = \frac{1-\bar{p}}{\bar{p}} \frac{c_v + f}{\xi d - c_v - f},$$

and a positive settlement amount,

$$\sigma^* = \xi d - c_v - f$$

with probability 1-x.

3. V accepts positive offer σ^*, and rejects zero offers with probability

$$r = \frac{\xi d - c_v - f}{d + c_d}.$$

Therefore, $p_{win} = \frac{x\bar{p}}{1-\bar{p}+x\bar{p}}$.

V's incentive compatibility requires the following:

$$\begin{aligned}
&\pi_V = (\xi d - c_v - f - f_0)\bar{p}(1-x) + (-f_0)(1-\bar{p}+x\bar{p}) \\
&= (\xi d - c_v - f)\bar{p}(1-x) - f_0 \geq 0 \\
&\implies \bar{p} \geq \frac{f_0}{(\xi d - c_v - f)(1-x)} \\
&\implies \bar{p} \geq \frac{c_v + f + f_0}{\xi d}.
\end{aligned}$$

Under such a signaling strategy, L's payoff in equilibrium is:

$$\begin{aligned}
\pi_L &= (p'_s + k(1-p'_s))(f_0 + (1-\bar{p}+x\bar{p})r(f + \frac{x\bar{p}}{1-\bar{p}+x\bar{p}}(1-\xi)d)) \\
&= p'_s f_0 + (1-p'_s)\left(f_0 + \frac{\xi d}{d+c_d}\left(f + \frac{1-\xi}{\xi}(c_v+f)\right)\right)k \\
&= p'_s f_0 + (1-p'_s)\left(f_0 + \frac{d}{d+c_d}\left(f + (1-\xi)c_v\right)\right)k.
\end{aligned}$$

V's payoff in equilibrium for each case filed is:

$$\begin{aligned}
\pi_v &= (\xi d - c_v - f - f_0)\bar{p}(1-x) + (1-\bar{p}+x\bar{p})(1-r)(-f_0) + \\
&(1-\bar{p}+x\bar{p})r\left[\frac{x\bar{p}}{1-\bar{p}+x\bar{p}}(\xi d - c_v - f - f_0) + \frac{1-\bar{p}}{1-\bar{p}+x\bar{p}}(-c_v - f - f_0)\right] \\
&= \xi d\bar{p} - c_v - f - f_0 \\
&= \frac{p_s'\xi d}{p_s' + k(1-p_s')} - c_v - f - f_0
\end{aligned}$$

Thus, V's expected payoff in equilibrium under L's signaling strategy is:

$$\begin{aligned}
\pi_V &= (p_s' + k(1-p_s'))\pi_v \\
&= p_s'\xi d - (c_v + f + f_0)(p_s' + k(1-p_s')).
\end{aligned}$$

Therefore, L's utility is:

$$\begin{aligned}
U_L &= (1-\delta)\pi_L + \delta\pi_V \\
&= (1-\delta)\left\{p_s'f_0 + (1-p_s')\left(f_0 + \frac{d}{d+c_d}\left(f + (1-\xi)c_v\right)\right)k\right\} \\
&+ \delta[p_s'\xi d - (c_v + f + f_0)(p_s' + k(1-p_s'))].
\end{aligned}$$

By the first order condition,

$$\begin{aligned}
\frac{\partial U_L}{\partial k} &= (1-\delta)(1-p_s')\left(f_0 + \frac{d}{d+c_d}\left(f + (1-\xi)c_v\right)\right) - \delta(c_v + f + f_0)(1-p_s') > 0 \\
&\implies \delta < \delta* = \frac{1}{1+\kappa},\ \kappa = \frac{c_v + f + f_0}{f_0 + \frac{1}{1+c_d/d}(f + (1-\xi)c_v)}.
\end{aligned}$$

Therefore, when $\delta < \delta^*$, L's optimal strategy is to choose the highest k possible. Because $\bar{p} = \frac{p_s'}{p_s' + k(1-p_s')} \geq \frac{c_v+f+f_0}{\xi d}$, $k_{max} = \frac{p_s'}{1-p_s'}\frac{\xi d - c_v - f - f_0}{c_v + f + f_0}$. This is the same choice of k in section 3, when $\delta = 0$.

One the other hand, when $\delta \leq \delta^*$, L's optimal strategy is to choose the lowest k possible, namely, $k = 0$. In such a case, L always truthfully reports the state $x = 0, \bar{p} = 1, p_{win} = 0$. Furthermore, $\pi_V = p_s'(\xi d - c_v - f - f_0)$; $\pi_L = p_s'f_0$. This is the same as the equilibrium where there are two perfectly informed agents, D and V. V files cases when D is liable, and D offers a positive settlement whenever V files cases against him. Therefore there is no trial.

F Extension 3: Persuasion in Litigation

As introduced in Section 5.3, α is the probability that V wins a liable cases at trial; and β is the probability that V wins a non-liable case at trial. J rules a case liable if and only if $\mu(\omega_l) \geq \frac{1}{1+\gamma}$.

F.1 Determining α and β

- J maximizes his expected utility. Thus, J will rule in favor of D when

$$
\begin{aligned}
& Eu(D\ win) \geq Eu(V\ win) \\
\Longrightarrow\ & \mu(\omega_{nl}) * u(D\ wins|\omega_{nl}) + \mu(\omega_l) * u(D\ wins|\omega_l) \\
& \geq \mu(\omega_{nl}) * u(P\ wins|\omega_{nl}) + \mu(\omega_l) * u(P\ wins|\omega_l) \\
\Longrightarrow\ & \mu(\omega_l) * (-\gamma) + (1 - \mu(\omega_l)) * 0 \geq \mu(\omega_l) * 0 + (1 - \mu(\omega_l)) * (-1) \\
\Longrightarrow\ & \mu(\omega_l) \leq 1/(\gamma + 1).
\end{aligned}
$$

- When J's prior belief $\mu_0(\omega_l) > \mu^*(\omega_l)$, D can send the optimal signal as in Proposition 2 to J, resulting in two beliefs: $\mu_s(\omega_l) = 1,\ \mu_s(\omega_l) = \mu^*(\omega_l)$.

  D loses in the former case, and wins in the latter.

- To be credible ,

$$
\sum_{Supp(\tau)} \mu\tau(\mu) = \mu_0
$$

$$
\begin{aligned}
&\Longrightarrow y * 1 + (1 - y) * \mu^*(\omega_l) = \mu_0(\omega_l) \\
&\Longrightarrow y = \frac{\mu_0(\omega_l) - \mu^*(\omega_l)}{1 - \mu^*(\omega_l)}.
\end{aligned}
$$

Here, y is the probability that D loses at trial. D wins at the threshold belief, and the number of cases that D wins $(1-y)$ is maximized.

- Further, D loses only when liable, and D wins some of the liable cases,as well as all non-liable cases. In other words, V loses all non-liable cases, and wins some liable cases.

- Therefore, when $\mu_0(\omega_l) > \mu^*(\omega_l) = \frac{1}{\gamma+1}$,

$$\begin{aligned} &\beta = 0, \\ &\alpha = \frac{y}{\mu_0(\omega_l)} = 1 - \frac{1-\mu_0(\omega_l)}{\gamma\mu_0(\omega_l)}. \end{aligned} \tag{24}$$

α is determined in the separating equilibrium (see subsection B.2) to be $\frac{1+\gamma}{d/c_v+\gamma}$.

- $\mu_0(\omega_l)$ is the probability of D being liable in a litigated case. When $\mu_0(\omega_l) < \frac{1}{\gamma+1}$, D always wins, and $\alpha = \beta = 0$.

F.2 Separating Equilibrium with Randomization

F.2.1 Case 1: $0 \le \frac{c_v}{d} \le \alpha$, and $p \ge \frac{c_v/d}{\alpha}$; α is determined to be $\frac{1+\gamma}{d/c_v+\gamma}$

- D offers 0 in ω_{nl} with probability 1. In ω_l, D offers 0 with probability x, and offers $\sigma^* = \alpha d - c_v$ with probability $1-x$.

- Offer $\sigma \ge \sigma^*$ is accepted; any offer $\sigma < \sigma^*$ is rejected with probability r.

- V is indifferent regarding the choice between accepting and rejecting when she is offered 0:

$$\begin{aligned} &(\frac{xp}{xp+(1-p)})(\alpha d - c_v) + (1 - \frac{xp}{xp+(1-p)})(0-c_v) = 0 \\ &\frac{\alpha xp}{xp+(1-p)} = \frac{c_v}{d} \\ &\implies x = \frac{1-p_s}{p_s}\frac{c_v/d}{\alpha - c_v/d}. \end{aligned}$$

Liable D is indifferent regarding the choice between offering σ^* and offering 0:

$$
\begin{aligned}
&-(\alpha d - c_v) = r(-\alpha d - c_d) + (1-r)0 \\
&\implies \quad r = \frac{1 - c_v/\alpha d}{1 + c_d/\alpha d}.
\end{aligned}
\tag{25}
$$

- Non-liable D prefers the offer 0 over the offer of σ^* because:

$$
\alpha d - c_v > r c_d
$$

- V's posterior belief is the following: $\mu_s(\omega_l|\sigma^*) = 1$, $\mu_s(\omega_1|0) = \frac{xp}{xp+(1-p)}$.

- The prior $\mu_0(\omega_l)$ is determined by the cases that go to court trials: $\mu_0(w_l) = \frac{xp_s}{1-p_s+xp_s} = \frac{c_v/d}{\alpha}$.

- From the results of subsection F.1, $\alpha = 1 - \frac{1-\mu_0(\omega_l)}{\gamma\mu_0(\omega_l)}$. Therefore, $\alpha = \frac{1+\gamma}{d/c_v+\gamma} < 1$.

- Further, $\mu_0(w_l) = \frac{c_v/d}{\alpha} = \frac{1+\gamma c_v/d}{1+\gamma} > \mu^*(\omega_l) = \frac{1}{\gamma+1}$ holds.

- The trial rate is $(1-p+xp)r$, where

-
$$
x = \frac{1-p_s}{p_s}\frac{1/\gamma + c_v/d}{1-c_v/d}; \; r = \frac{\gamma(1-c_v/d)}{1+\gamma+c_d/c_v+\gamma c_d/d}.
\tag{26}
$$

- The restrictions on the parameters are the following:

$$
\begin{aligned}
0 \le x, r \implies 0 \le \frac{c_v}{d} \le \alpha \implies c_v < d \\
x \le 1 \implies p \ge \frac{c_v/d}{\alpha} \implies p \ge \frac{1+\gamma c_v/d}{1+\gamma}.
\end{aligned}
$$

F.2.2 Case 2

If $c_v > d$ or $p < \frac{1+\gamma c_v/d}{1+\gamma}$, then there is no separating equilibrium. Rather, there is pooling equilibrium where the settlement offer is 0.

F.3 Pooling Equilibrium

F.3.1 $\sigma = 0$ when $\alpha \leq \frac{c_v}{d}$

This case is equivalent to the case of $c_v > d$, as discussed in F 2.2.

F.3.2 $\sigma = 0$ when $p \leq \frac{c_v/d}{\alpha}$ and $0 < \frac{c_v}{d} < \alpha$

This is equivalent to the case when $c_v < d$ and $p < \frac{1+\gamma c_v/d}{1+\gamma}$.

- V accepts the settlement offer of 0 in equilibrium because:

$$p(\alpha d - c_v) + (1-p)(-c_v) \leq 0.$$

- D's and V's equilibrium payoffs are both 0
- V's belief in equilibrium is $p(\omega_l) = p$
- D has no incentive to deviate in either state, as offering 0 is the dominant strategy in both states, ω_l and ω_{nl}.

F.3.3 $\sigma = \alpha pd - c_v$ when $\frac{c_v/d}{\alpha} < p < \frac{c_v/d + c_d/d}{\alpha}$ and $0 < \frac{c_v}{d} < \alpha$

- V accepts the settlement σ in equilibrium. V's equilibrium payoff is

$$\pi_V = \alpha pd - c_v.$$

  V has no incentive to deviate, as the settlement amount would be the same as the expected payoff from a trial.

- V would go to trial if she is offered 0:

$$p(\alpha d - c_v) + (1-p)(-c_v) > 0.$$

- However, D's payoff would be lower following a trial. For non-liable D:

$$\alpha pd - c_v < c_d$$

For liable D, the expected payout in a trial would be even lower.

- Therefore, D would not deviate from offering σ.

F.3.4 No pooling equilibria when $p \geq \frac{c_v/d+c_d/d}{\alpha}$ and $\alpha > \frac{c_v}{d}$

- When $p \geq \frac{c_v/d+c_d/d}{\alpha}$,

$$c_d < p(\alpha d - c_v) + (1-p)(-c_v) < \alpha d + c_d.$$

- V will only accept offers $\sigma \geq p(\alpha - c_v) + (1-p)(-c_v)$; however, D in $\Omega = \omega_{nl}$ would prefer to offer 0 and pay c_d at trial rather than offering σ.

- D in $\Omega = \omega_l$ would prefer to offer σ rather than to offer 0 and incur costs $\alpha d + c_d$ at trial.

F.4 Equilibria Selection: Pooling Equilibria when $sigma = \alpha pd - c_v$ hen $\frac{c_v/d}{\alpha} < p < \frac{c_v/d+c_d/d}{\alpha}$ and $0 < \frac{c_v}{d} < \alpha$ Do Not Survive the D1 Criterion

The D1 creition in (Cho & Kreps, 1987) requires that when there is a type t' who wishes to defect and send message m whenever type t wishes to do so, then the t sends message m, (t, m) is pruned from the game. Formally,

$$D_t = \left\{ \phi \in MBR(T(m), m) : u^*(t) < \sum_r u(t, m, r)\phi(r) \right\},$$
$$D_t^0 = \left\{ \phi \in MBR(T(m), m) : u^*(t) = \sum_r u(t, m, r)\phi(r). \right\}$$

If for some type t there exists a second type t' with $D_t \cup D_t^0 \subseteq D_{t'}$, then (t, m) may be pruned from the game. Here,

- u^* is the expected payoff in equilibrium; ϕ is the receiver's mixed best response to m; and $\sum_r u(t, m, r)\phi(r)$ is the sender's expected deviation payoff given the best response.

- Consider the case where both liable and non-liable D can offer 0 as the settlement. Because $-c_v < 0$ and $\alpha d - c_v > 0$, V plays the mixed strategy of accepting or rejecting when the type is unknown. Let $\phi = (1 - y, y)$ for the probability of (accept, reject)

- For non-liable D, $-\alpha pd + c_v < (1 - y) * 0 - yc_d \implies y \leq \frac{\alpha pd - c_v}{c_d}$.

- Therefore, $D_{nl} = [0, \frac{\alpha pd - c_v}{c_d})$; $D_{nl}^0 = [0, \frac{\alpha pd - c_v}{c_d}]$.

- Similarly, for liable D, $D_l = [0, \frac{\alpha pd - c_v}{\alpha d + c_d})$; $D_l^0 = [0, \frac{\alpha pd - c_v}{\alpha d + c_d}]$.

- $D_l \cup D_l^0 \subseteq D_{nl}$. Therefore, liable D is pruned for sending as settlement of 0. That is, $(liable, 0)$ is ruled out.

- Thus, whenever V sees a settlement of 0, V believes that this is from a non-liable D, and she will accept it because $-c_v < 0$. Non-liable D will defect, and the pooling equilibrium will be eliminated.

F.5 Summary of Equilibrium in the Two-agent Model When D Persuades J

As obtained earlier, V's trial winning probability for a liable case is α, and for a non-liable case is β, where

$$\alpha = \frac{1 + \gamma}{d/c_v + \gamma}; \ \beta = 0.$$

The equilibria of the settlement game, when a trial is not true revealing, is as follows.

1. The separating Equilibrium when $p_s \geq \frac{1+\gamma c_v/d}{1+\gamma}$:

   (1) The main case is obtained when $p_s \geq \frac{1+\gamma c_v/d}{1+\gamma}$. In such a case, there is a separating equilibrium where

   1 if not liable, D offers 0 settlement and there is no litigation;

   2 if liable, D randomizes between two offers: zero with probability

$$x = \frac{1-p_s}{p_s}\frac{c_v/d-\beta}{\alpha-c_v/d} = \frac{1-p_s}{p_s}, \frac{1/\gamma+c_v/d}{1-c_v/d},$$

   and a positive settlement amount,

$$\sigma^* = \alpha d - c_v = \frac{1+\gamma}{d/c_v+\gamma}d - c_v..$$

   with probability $1-x$;

   3 V accepts positive offers σ^*, and rejects zero offers with probability

$$r = \frac{1-c_v/\alpha d}{1+c_v/\alpha d} = \frac{\gamma(1-c_v/d)}{1+\gamma+c_d/c_v+\gamma c_d/d}.$$

2. The pooling equilibrium when $p \leq \frac{1+\gamma c_v/d}{1+\gamma}$:

   D offers zero settlement, and there is no litigation.

3. The probabilities of having a trial and winning at trial when $c_v < d$:
   Under the separating equilibrium of the main case $p_s > \frac{1+\gamma c_v/d}{1+\gamma}$, a trial occurs when V rejects D's zero offers. Such a condition also implies $c_v < d$. The probability of a trial is

$$\begin{aligned}(1-p_s+p_s x)r &= (1-p_s)\frac{\alpha}{\alpha+c_d/d} = (1-p_s)\frac{1+\gamma}{1+\gamma+c_d/c_v+\gamma c_d/d} \\ &= (1-p_s)\frac{1}{1+\frac{c_d/c_v+\gamma c_d/d}{1+\gamma}} = \frac{\beta_1}{1-\beta_0}\frac{1-p_0}{p_0}\frac{1}{1+\frac{c_d/c_v+\gamma c_d/d}{1+\gamma}}.\end{aligned}$$

   The probability of winning at trial is determined by the proportion of liable and non-liable cases among cases that go to trial:

$$\frac{xp_s}{1 - p_s + xp_s}\alpha = \frac{c_v}{d}.$$

G Proof of Proposition 13

Proof. Using the optimal signal, D first sends a signal to cause J to believe $p(\omega_l) = 1$ for some ω_l cases; and to believe $p(\omega_l) = p^* - \epsilon$, $\epsilon > 0$ for all ω_{nl} cases and some ω_l cases. Let N denote the total number of cases, and $n'_{1,l}, n'_{1,nl}$ denote the number of liable and non-liable cases in round 1 after D's persuasion, respectively. This process satisfies the following: $p_0 = \frac{n'_{1,l}}{N} + \frac{n'_{1,nl}}{N}(p^* - \epsilon)$.

L then sends a signal to affect J's belief regarding $p = p^* - \epsilon$ cases, and causes $p(\omega_l) = 0$ for some ω_{nl} cases, and $p(\omega_l) = p^* + \delta$ ($\delta > 0$) for the remaining mixture of ω_l and ω_{nl} cases. Let $n_{1,l}, n_{1,nl}$ denote the number of liable and non-liable cases in round 1 after L's persuasion, respectively. This process is described as the following: $p^* - \epsilon = 0 + \frac{n_{1,l}}{n'_{1,nl}}(p^* + \delta)$. Then the number of non-liable cases from the first round is $n_{1,l}$ from the equation, and the number of liable cases from round 1 is $n_{1,nl} = n'_{1,l} + n'_{1,l} - n_{1,nl}$. J's beliefs are $p(\omega_l) = 1$ for cases in $n'_{1,l}$ (i,e., case identified as liable after the first round of D's persuasion); $p(\omega_l) = p^* + \delta$ on $n_{1,l}$ cases (i.e., cases identified as liable after the first round L's persuasion); and $p(\omega_1 = 0)$ for $n'_{1,nl} - n_l$ cases (i.e., case identified as non-liable after the first round L's persuasion). Such beliefs are correct.

In the next round of persuasion, D and L persuade J on the $n_{1,l}$ cases where J's correct prior belief is $p(\omega_l) = p^* + \delta$. The process is the same as that in the first round: D sends a signal to help J recognize some ω_l cases and to have the belief of $p^* - \epsilon$ in the remaining mixture. Then L sends a signal to help J recognize some ω_{nl} cases and to have belief $p^* + \delta$ in the remaining mixture.

As the process goes on, eventually, the true states for all cases are revealed. $\square$